"Method of Removing Rock under Water, as adopted in the Enlargement and Deepening of the Harbor and Entrance Channel to the Welland Canal at Port Colborne."*

BY CHARLES JAMES ASSOC. M. INST. C. E.

The removal of large bodies of rock under water has for many years engaged the attention of some of the most eminent engineers on the Continent of America; but owing to the difficulties and cost attending such operations until recently this class of work has seldom been undertaken.

Within the past twenty years considerable advances have been made in this branch of engineering, and at the present time extensive works are being carried out in improving the navigation of the Detroit and the St. Lawrence rivers, the method generally adopted for these works being similar to that introduced about sixteen years ago in the harbor works at Erie, Pennsylvania, and subsequently carried out with complete success in the enlargement in and deepening of the harbor and entrance channel to the Welland Canal, at Port Colborne.

A contract for this work was awarded, in December, 1871, by the Dominion Government, and included, amongst other matters, the removal of between 15,000 and 20,000 cubic yards of rock at the depth of from 10 to 15 feet under water. The contract price for rock-work was $6.50 per cubic yard; but this contract was abandoned after several months spent in ineffectual attempts to displace the rock with "Giant Powder."

In 1875 tenders were again called for, the depth of water from the harbor outwards to be increased from its then average depth of 12 feet to a minimum depth of 17 feet; this involved the removal of several reefs of blue limestone rock thickly studded with flint. Many tenders were received, ranging from $9.90 to $40 per cubic yard for rock under water. The contract was awarded to Mr. Charles F. Dunbar, of Erie, Pennsylvania, the contract price being $9.90 per cubic yard.

From former experiments made in this class of rock, it was found that a more powerful explosive than any heretofore used was requisite and that to make the charge thoroughly effective the explosive must be confined to the smallest possible space at the bottom of the hole, and be placed at such a depth as would cause the entire force of the charge to be exerted upwards on the mass to be removed.

It was therefore determined to make a trial with pure nitro-glycerine, and to place the charge from 12 to 15 inches below the required bottom.

The first experiments, though not altogether successful, were highly encouraging, and in the course of a few weeks a method of submarine blasting was perfected that commends itself to the notice of engineers engaged in similar undertakings.

A rectangular flat-bottomed scow 30 by 50 feet, drawing about 2 feet of water, was used to carry the plant. This comprised a boiler and engine, with two 8-inch cylinders, for hoisting anchors; two "Ingersoll" drills, having cylinders 5 inches in diameter and a length of stroke of 8 inches, averaging about four hundred strokes per minute, and a blacksmith's shop for repairing and making drills. The size of drill varied between 1¾ inch and to 2½ inches in diameter, with four cutting edges of steel, highly tempered, radiating at right angles from the centre. Each drill worked in an independent sliding frame, on a tramway of strap-iron laid on the deck, and so placed as to allow sufficient room for the free working of the drill alongside the scow. A hose connected with the boiler supplied the motive power, the cut-off being placed within easy reach of the man attending the drill. The scow was kept in position by four drop-anchors of heavy oak timber, two at each end, similar to those used on dredgers, and secured in a strong frame raised about 9 feet above the deck.

The hands employed were; a foreman, blacksmith and assistant, four men attending drills, and one blaster and assistant.

Holes were drilled in the rock 5 feet apart, generally about 30 inches below the required depth, a cast-iron shell weighing about 100 pounds being used to steady the lower end of the drill when entering the rock. This shell was about a foot in height, 15 inches in diameter at the base, standing on three pivots or legs, about 3 inches long, convex on the top, through the center of which a hole passed vertically admitting of the free working of the drill; ropes were attached leading to the scow, by which it was lowered and raised.

When the drilling of each hole was completed, the sediment was removed by forcing water through a tube reaching from the deck to the bottom of the hole, a "Blake" pump and hose being employed for that purpose.

The cartridge, a tin canister ⅞ inch in diameter, 15 inches long, was filled with explosive to within about an inch of the top, the exploder (fulminate of mercury) enclosed in a copper capsule, into which the insulated copper wires were passed, and to which they were secured by the maker, was inserted in the cartridge. This was sealed and attached to similar wires of sufficient length to reach the bottom of the hole and connect with the electric battery on the scow. The cartridge was next placed in a tin tube 1¼ inch in diameter about 20 feet long, through one end of which a slit in the side extending the full length of the cartridge admitted the easy passage of the insulated wires; the latter were drawn tightly, passing along outside the tube, which was carefully lowered to the bottom of the hole. A wooden rod was gently pushed by hand through the tube, to keep the cartridge down, and the tube withdrawn.

A quantity of explosive, varying from 2 pounds to 5 pounds in proportion to the depth of rock, was then poured through a funnel-shaped copper tube into the hole, and afterwards a few gallons of hot water to remove any particles of explosive adhering to the sides of the tube, the wires were finally connected with the battery and the charge exploded.

The practice generally followed was to charge and explode each hole as soon as the drill was removed, and before commencing to drill another hole, as any disturbance of the wires after loading tended to injure the circuit. The explosive, before being used, was congealed by packing in ice and sawdust; the temperature was raised before loading to 60° Fahrenheit by immersing the can in hot water. The loading of each hole occupied only a few minutes, but had to be conducted with the greatest care, the following rules being strictly observed:

1. That the hole was drilled to a sufficient depth below the required bottom.

2. That the cartridge was placed at the bottom of the hole.

3. That in withdrawing or inserting the tubes and completing the loading no obstruction was allowed to enter the hole.

The necessity for such precautions is obvious, from the fact that pure nitro-glycerine can only be exploded by concussion, hence the necessity for placing the cartridge containing the exploder in such a position as would ensure its contact with the liquid explosive that completed the charge, and which, owing to its specific gravity, would speedily fill every space around the cartridge, and penetrate every fissure of the rock. The electric spark transmitted through the exploder caused almost instantaneous concussion, and exploded the whole charge, yet to a person standing on the scow, or in close proximity to the works, two distinct explosions in rapid succession could always be felt and heard.

Several experiments were made to ascertain at what temperature the explosive became dangerous. At 32° Fahrenheit it was found to be non-explosive, at 40° it required careful handling, and at 60° became highly sensitive, needing the exercise of the greatest vigilance. A single accident occurred during the four years over which this work extended, at a considerable distance from the works.

After blasting, the rock was easily removed by the dredge; a few instances occurred where it was necessary to return with the drill, but only at the commencement of the work. Subsequently the bottom was carefully dragged, a derrick scow and diver being used to pick up any blocks of stone that had escaped the dredge.

Finally soundings were taken at intervals of 5 feet; the result showed an average depth of 17½ feet, with a minimum depth of 17 feet, and a total of 34,600 cubic yards of rock removed.

The consumption of explosives was 45,600 pounds at an average cost of $1 per pound; the area of rock surface removed was 303,000 square feet, with an average depth at the line of 17 feet water of 2.58 feet. Assuming each hole to have been drilled 2½ feet below the required bottom, and the area of rock surface to have been 25 feet to each hole, the annexed table is submitted as a close approximation of the work performed.

Area of rock surface	303,000 square feet.
" to each hole	25 "
Number of holes drilled	12,120 "
Average depth per hole	5.08 lineal feet.
Total depth drilled	61,569 "
Average charge per hole	3.76 lbs.
" per cubic yard	* 1.32 "
Rock removed	34,600 cubic yards
Quantity of explosive used	45,6 0 lbs.
Average depth of water obtained	17½ feet.

* From Proceedings of the Institution of Civil Engineers.

The Daily Traffic over Broadway, New York.

Whatever may be thought of Jacob Sharp's Broadway surface-railroad, he has been the cause of the gathering of some interesting statistics regarding the enormous amount of traffic in Broadway. Four men were recently stationed at Fulton Street and Broadway to count the vehicles passing through Broadway at that point from 7 A. M. to 6 P. M. The total number was 22,308 for the period of eleven hours—about 2,000 an hour, thirty-three a minute, or one every two seconds. The largest number of any one kind of vehicles was of single and double trucks, 7,384; the smallest number was two; these were ambulances. There were 3,390 single and double express wagons. The 2,310 stages and the 1,022 cabs were next in order of quantity, pedlers' wagons numbering 938, produce wagons 446, rag trucks 375, carriages 354, coal carts 324, and venders wagons 300. Then there was a drop to hacks, 288, and butcher wagons 223. The variety of vehicles was striking, there having been eighty kinds according to the schedule. Every conceivable article of transfer appears to be poured into Broadway. The private carriages were completely engulfed in the 150 ash-carts; the two ambulances and three funerals made a melancholy showing amid the seventy-three loads of dead hogs, and the sixty-four garbage and the seventy-three dirt carts. The lager beer wagons and the orange pedlers flourished on an equality; the bone and lumber wagons went neck-and-neck; the pie and the sugar wagons were half and half, which should give the pies sweetness; the milk were left behind by the swill wagons. The mixture presented was something appalling. Kerosene, milk old iron, sawdust, rags, sugar, ice, beer, bones oranges, ashes, pie, hogs, tripe, tin, tallow, tea, tar, and undertakers were commingled in a bewildering confusion. Broadway is certainly a remarkable thoroughfare. *New York Tribune.*

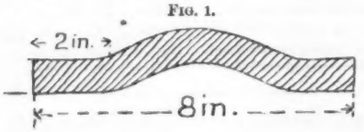
The "Crinoline" Chimneys of the Cambria Iron Company at Johnstown, Pa.*

BY MR. GEORGE WEBB.

These chimneys, Fig. 2, are connected to the boiler-house by underground brick conduits, and are intended as "uptakes" for the unused gases. The surplus gases are used for generating steam, and but little is left after passing under the boilers. Sometimes the fires under the boilers must be reinforced with raw coal, in which case the chimneys convey some smoke. The ground is bad, and hence there is a deep foundation of masonry below the surface. From the entrance of the conduit to about 8 feet above the surface, the base of the chimney is hexagonal, of hammered stone, surmounted by a cut-stone coping. Six 3-inch anchor bolts are built into this base and provided with suitable nuts to hold down a base-plate 4-inches thick, and with an upward projecting rim six inches high around a circle 12 feet in diameter. From this base-plate it is 140 feet to the top of the chimney. At the top is a moulded cast-iron plate similar to the base plate, with the rim projecting downward, 10 feet 2 inches in diameter. The batter is, therefore, 22 inches in 140 feet.

Between these two plates the "crinoline" is constructed. It consists of sixteen vertical lines of ordinary wrought-iron railroad rails, 4-inch base, with the base outward, surrounded by forty-five hoops. The rails may be in sections of any length which will allow of the splice being riveted to a hoop, care being taken to avoid having more than one rail-splice on the same hoop. Well-selected old iron rails with good bases or sound sections of No. 2 or No. 3 rails are as good as any.

FIG. 1.



The hoops are of wrought iron, rolled from iron ¾-inch thick into the section shown in Fig. 1.

Each hoop is in two pieces, bent cold to a true segment in a wedge-adjusting bending-machine, which allows any desired delicacy of touch. The piece lies on edge while being bent, the "former" being more readily tried in that way. If bent hot the curve cannot be maintained while cooling.

The two halves of each hoop are spliced on the inside with flat plates, secured with four rivets and one bolt in each end of each section, care being taken that at least three hoops shall intervene solid before another hoop-splice is made between the same verticals. There are 45 hoops, the bottom one being near the base-plate projection, and, therefore, about 12 feet in diameter. The distance in the clear from this hoop to the next one above is 22 inches. The clear distance between each pair of hoops gradually increases from the bottom to the top, the distance in the clear between the top hoop and the next below being 54 inches.

Each hoop is riveted to each rail with two rivets, one in the upper flat space of the hoop and the other on the other flange of the rail in the lower flat space of the hoop.

The iron skeleton thus made is so stable that no scaffolding is used in construction. Two boards across a lower ring will hold a portable forge. A rail section is hauled up, put in place, adjusted and riveted; then others in the same way.

The center opening of the chimney is 8 feet, which is preserved throughout. The bricks fill from this center opening to the inner side of the hoops, special bricks being moulded to fit around the rail heads and thus save time and waste of cutting. To save cutting bricks the masons carried the inside parallel with the outer batter, and when the inside got to 8 feet in the clear, they set back on the inside to an even brick, and then followed the outer batter until the inner diameter reached 8 feet again, and so on. There are about 1,000 bricks average to one foot in height of stack.

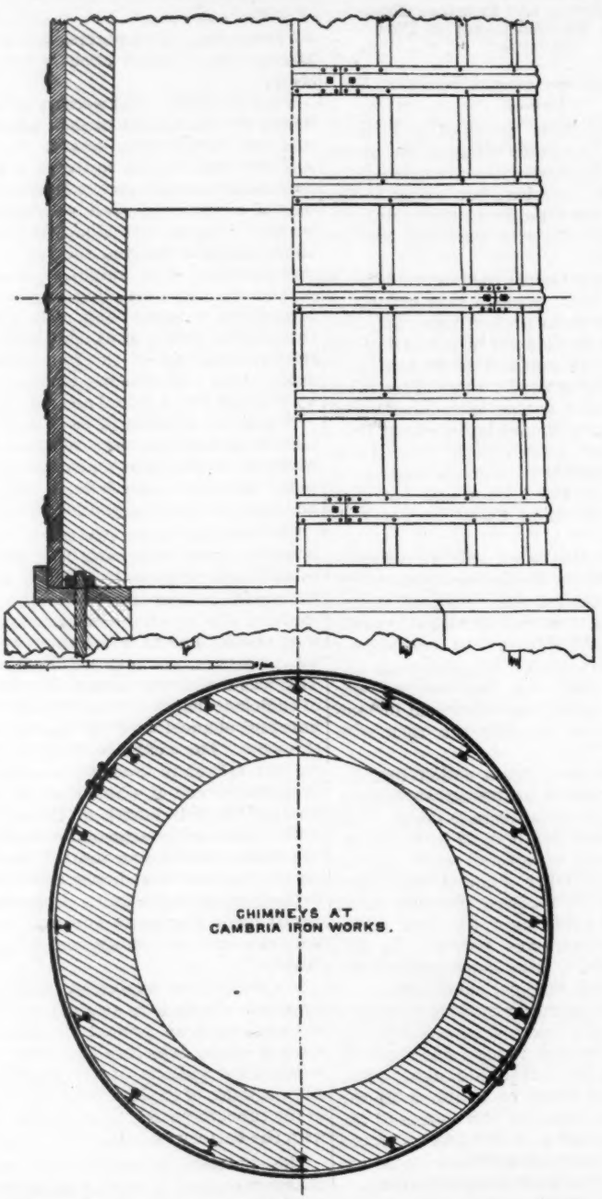
Five bricklayers and nine laborers lined the first chimney built in 21 days, the next in 18½ days. They used no scaffolding but two scantlings and a few boards on the inside at convenient intervals, thus leaving a well-hole open the entire height. These were removed from the top downward after completion.

A light iron ladder is riveted to (say) every third hoop, the entire height. The convenience of this for construction, examination and repairs, if needed, is obvious.

The strength of this chimney is in the "crinoline." The bricks are merely for enclosure of the gases. Their mass is so small and the walls are so thin that they are never hot. The "crinoline" of the first chimney was built the entire height before the brickwork was begun. Some heavy storms occurred while it stood thus and it never wavered.

*Reprinted from Transactions of the American Society of Civil Engineers, April, 1885.

FIG. 2.—THE "CRINOLINE" CHIMNEYS OF THE CAMBRIA IRON COMPANY; JOHNSTOWN, PA.



ENGINEERING NEWS Three months for One Dollar.

Moving a Chimney.

One of the most difficult transfers of heavy structures yet attempted was successfully completed in Salem, Massachusetts, a few weeks ago, where a brick factory chimney, ninety feet high and only six and one half feet in diameter at the base, was taken up and moved, with the aid of six men and two horses, one hundred feet, and safely deposited upon a new foundation. The chimney was nearly cylindrical, the upper diameter being five feet; and it was estimated that a sway of three inches from the vertical would bring it to the ground so that great precautions were taken to prevent lateral movement in transferring it to the platform on which it was to be transported.

A cage was first built around the chimney, consisting of horizontal timbers supporting shores, which extended twenty-three feet up the sides of the shaft, and were reinforced by a second set of shorter ones beneath. After these were in place, and well secured holes were cut through the brickwork, and needles inserted, under which thirty-four jackscrews were placed, and the shoring and shaft raised together, high enough to allow a rough platform to be set in place. The platform, which was of strong plank, extended to the new position of the chimney, and by levelling it carefully, and employing a large number of rollers the load, weighing one hundred and thirty tons, was easily moved into place.—*American Architect.*

The Preservation of Timber.

Abstract of a Report of a Committee of the Am. Soc. C. E. Presented at the Annual Convention of June 24, 1885.

The committee, appointed in 1880, was made up as follows: O. Chanute, B. M. Harrod, G. Bouscaren, E. R. Andrews, E. W. Bowditch, C. S. Smith, J. W. Putnam, G. H. Mendell and Frederic Graff, *ex officio*.

The first subject considered is the necessity for preserving timber. The census of 1880 proves that the time has now arrived when railway and other interests must largely resort to the artificial preservation of timber in the United States.

Attention was first practically drawn to this subject of artificial preservation in the United States by the report in 1858 of Messrs. Colburn and Holley upon European Railways, in which they described the preparation of sleepers against decay. This report brought out a plentiful crop of American inventions to cheapen the processes.

In Europe the demand for timber following the introduction of railroads early brought into existence a number of methods for preserving timber and Mr. W. P. Moir, in a paper read in 1869 before the Philosophical Society of Glasgow, gives the following list of the names of the patentees and the most valuable compounds employed:

Kyan	1832	Chloride of Mercury.
Margary	1837	Sulphate of Copper.
Bethell	1838	Creosote or pitch oil.
Bethell	1848	
Burnett	1838	Chloride of zinc.
Burnett	1840	
Boucherie	1839	Pyrolignite of iron.
Boucherie	1846	Sulphate of copper.
Payne	1814	Sulphate of iron.
Payne	1846	Carbonate of soda.

Concerning the modes of application, Mr. Moir says:

"The methods employed practically in working these patents were three in number, namely; steeping, vital suction and pressing in close vessels; Kyan and Margary employed the first mentioned method; Boucherie employed the second, and Payne, Burnett and Bethell employed the third, which was also latterly adopted by Boucherie. The first and third methods required that the timber should be seasoned and free from sap."

The committee for the purpose of simplifing the consideration of the different processes as used in the United States have arranged them under the following heads:

1. Kyanizing—or use of corrosive sublimate.
2. Burnettizing—or use of chloride of zinc.
3. Creosoting—or use of creosote oil.
4. Boucherie—or use of sulphate of copper.
5. Miscellaneous—or use of various substances.

Kyanizing. This process introduced in 1832 consists in steeping the timber in a solution of corrosive sublimate. The proportions as ultimately used were one pound of the dry salt to ten gallons of water, or even fifteen gallons, and with the latter quantity the timber absorbed about 2½ pounds of the salt per 1000 feet board measure. This salt was also applied by the "Boucherie" process, but the timber was found to absorb too much of the salt and some of the solution was wasted.

As this salt now costs from 50 to 60 cents per pound, and as an absorption of 4 or 5 pounds per 1000 feet B. M. is considered sufficient, Kyanizing now costs about $6.00 per 1000 feet B. M. The committee present a list of sixteen experiments in using this process on various timbers and for various purposes, with the results of the trials. In commenting upon these results, it seems that when the process was used for railroad ties it was very generally a failure; but it was successfully applied to bridges and other structures not exposed to constant moisture. There are now two Kyanizing establishments in the U. S., one at Lowell, Mass., where the total actual cost of treatment is $4.25 to $5.30 per 1000 feet B. M., and the others on the Eastern R. R. at Portsmouth, N. H.

Burnettizing. The original practice by this method was to steep the timber in a solution of chloride of zinc, in the proportion of one pound to every four gallons of water. This was found tedious and the inventor, Sir Joseph Burnett, adopted the Bethell process of placing the timber in a closed iron cylinder, forming a partial vacuum to extract the sap, air and water, and then force in the liquid under pressure. This process has been improved by using steam in the first stages.

A record of 30 experiments, made from 1830 to 1883, is given by the committee. The results seem to prove that if well done, without undue haste and with seasoned timber, the process will increase the life of ordinary timber 50 per cent. Many of the failures recorded are evidently due to neglect of these rules. The P. W. & B. R. R. Co. put up its own works to secure proper manipulation and apparently overdid the thing by using a solution too strong with the result that the ties became as "brittle as carrots," and sometimes broke in unloading from the cars; the same trouble was found on the Phila. & Reading R. R. The first named company used a solution probably 5 to 6 per cent. strong, and the Reading Co. a 3¾ per cent. solution; the German experience fixes not over 2 per cent. or 1.91 per cent. as a standard. Hemlock, beech and maple ties burnettized have been found to last 16 years.

The committee do not consider the process applicable to bridges, as the timber becomes brittle; this was the case at the original Havre de Grace Bridge, where the solution used was said to be $1\frac{13}{100}$ per cent. strong; this proportion is doubted by the committee. The trouble with the process as applied to bridges is that if the zinc solution is made weak enough not to injure the wood, it is likely to wash out.

Burnettized ties usually decay from the outside toward the heart, as the chloride of zinc is a very deliquescent salt and readily washes out and allows decay to commence. This is just the reverse of the action in timber treated with creosote or dead oil; in this last case the heart wood is least penetrated by the oil and decay begins there.

The cost of Burnettizing, when well done, is about $5.00 per 1,000 feet, B. M., or 20 to 25 cents per tie. It is particularly adapted to the preservation of ties, and the committee recommended it as the available process from a point of cost. It is less adapted to bridges and trestles but will probably prove a success for wooden pavement if well done.

Creosoting.—This process consists in injecting the timber with hot creosote oil in a closed cylinder under pressure. It was invented in 1838 by Mr. John Bethell of England. This creosote is the oil of tar, and it is a powerful coagulator of the albumen in the wood, furnishes a water proof covering to the fibres and its antiseptic properties prevent putrefcation. The inventor recommended at least 7 pounds of creosote oil to each cubic foot of timbers for railroads, and for marine work not less than 10 pounds. Young growing timber, thoroughly dried, was best adapted to the process. In England 10 out of 12 leading railways are using creosoted ties, and sleepers have been preserved 22 years and are yet sound. As against the *teredo navalis*, English engineers considers 10 to 12 pounds to the cubic foot sufficient, but French engineers consider that 19 pounds is necessary to make the timber safe against this worm.

The English practice in creosoting is to use seasoned timber, while in this country we almost invariably use freshly cut timber. Our practice has lead to steaming the timber first in order to vaporize the moisture; this steaming process is being introduced abroad, even upon seasoned timber, and is considered a valuable improvement on the original process. Creosote is abundant and cheap in England, while it is comparatively scarce and dear here.

The committee gives a list of 34 trials of timber thus treated and comments upon the results as follows:—Treating with coal tar, from which creosote proper is made, was found to be useless. Some of the early failures of properly creosoted timbers was found to be caused by fitting and trimming the stick *after* the creosoting process; this trimming is now recognized here and abroad as fatal to lumber intended for marine purposes, as the *teredo* thus has made for it a pathway to the less impregnated heart wood.

The "Seely" process consists in immersing the wood in a closed iron tank of the oil and raising the temperature between 212° and 300° F. This was supposed to drive all the moisture out of the wood, and the hot oil was then suddenly replaced by a bath of cold oil which was to condense the steam remaining in the sap cells and then rush in and fill every pore in the wood thoroughly. The process has failed to become popular. In this connection the committee recount the rise, progress and general collapse of a number of patented processes based on the use of dead oil, rosin dissolved in naptha, rosin oil, smoky vapor of coal tar, etc. An examination made of ties in railroad track near Titusville, Pa., lying in ground completely saturated with crude petroleum, proved that these ties were more or less dozy and rotten, the oil in no way preserved them from decay as claimed by some enthusiasts. Experiments made with yellow pine blocks charged with 15 to 19 pounds of creosote to the cubic foot and exposed with untreated blocks for 698 days in Delaware Bay, showed the untreated blocks largely destroyed by the *teredo* and the treated blocks perfectly sound and nothing lost in weight. The "Webb" process of boring a longitudinal hole through the center of a tie or timber, plugging this hole at the end and then by a lateral hole filling the cavity with creosote oil, was found a failure as the oil thus barreled up did not disseminate itself much into the sap-wood, and creosote congeals at 60° F.

The committee in commenting generally on the creosoting process say, there is no process of wood preservation, the efficiency of which, when well done, is better established than this; but there is also no process in which more bad work is done from design or ignorance. The reason for the bad work is found in the cost. Creosote cost about one cent per pound and the supply is unequal to the demand. For protection against decay alone from 8 to 12 pounds per cubic foot seems necessary, and this rule applied to ties of 3 cubic feet makes 24 to 36 cents worth of creosote per tie; adding the cost of handling and working the plant and it will be found that to properly creosote a railroad tie costs from 35 to 60 cents each. This cost is prohibitory and it is generally cheaper to let the tie rot and replace it, at present prices.

For timber that is to be placed in very wet situations or exposed to marine worms, creosoting is the only method which insures success. The user must determine by surrounding conditions whether it will pay or not. Along the Gulf coast the *teredo* cuts off a pile in 8 months, and there creosoting *must* be resorted to; in northern harbors, or in water contaminated with sewage, mud, discharge from gas works, etc., the pile will last from 5 to 12 years. To perfectly protect timber against the *teredo* it seems to be established that from 10 to 20 pounds per cubic foot is required, depending upon exposure. The total cost may be estimated therefore at 14 to 24 cents per cubic foot, or $12 to $20 per 1000 feet B. M. for piles and timber exposed to marine worms, and from $10 to $14 per 1000 feet B. M. where decay alone is to be guarded against.

Boucherie Process. This process, invented

by Dr. Boucherie, contemplates forcing a solution of sulphate of copper longitudinally through the pores of the wood by hydraulic pressure. The inventor first used pyrolignite of iron, but later considered the sulphate of copper more effective. His first experiments, made between 1836 and 1846, were by vital suction, tapping the living tree and allowing the ascending sap to carry up the solution. This failing to give uniform results he then applied a cap to the end of a freshly cut log and allowed the solution to flow by pressure; or he sawed a log nearly through the middle and separating it at the edges by the insertion of a strip of tarred rope, into the cavity thus formed he bored a hole diagonally and admitted the solution under pressure.

This process requires about one pound of sulphate of copper to 100 gallons of water. It has been extensively used in France with satisfactory results for many years, but must be applied to freshly cut trees, in the log only; this involves delay, waste and annoyance, and it has been now abandoned. In our Northern States the process could not be applied at all during winter, when trees are usually cut, as the solution would freeze.

The Thilmany process is a modification of the "Boucherie." Mr. W. Thilmany proposed a double injection, first by muriate of barytes and secondly by sulphate of copper forced into the timber by pressure; later he changed his process so as to include the application of solutions under pressure in closed cylinders. The double solution was expected to form an invaluable compound proof against the *teredo* but such has not been proven by trial. In still another process Mr. Thilmany uses sulphate of zinc and chloride of barium. These processes give moderately satisfactory results as against decay in pavements, but experiments on railroad ties were not satisfactory.

Miscellaneous Processes. The *Earle* process consists of immersing the timber, etc., in a hot solution of 1 pound sulphate of copper, and 3 pounds of sulphate of iron mixed in 20 gallons of water. Experiments on 63,000 cubic feet of timber at Watervleit Arsenal, applied at a cost of 7 cents per cubic foot, showed that while it extended somewhat the life of the timber it impaired its strength and caused it to check and warp badly.

The *Lime* process includes the soaking of timber for about 3 months in a vat of lime water made as strong as possible. The results in use were unsatisfactory, as lime is a weak antiseptic (52.5 by atomic weight as against 216 for creosote)

Payenyzing or the use of sulphate of iron has been tried with unfavorable results.

Salt has been applied to 6 by 12 inch hemlock ties by boring 1½ inch auger holes 10 inches deep every 15 inches, and filling the holes with common salt and then plugging them up. The life of the tie was somewhat lengthened but the process did not pay. Salt is a cheap but weak antiseptic, being 58.8 by atomic weight as against 135.5 for chloride of mercury.

Charring the outside of fence posts and then dipping them about 3 feet into a hot mixture of raw linseed oil and pulverized charcoal, and setting butt-end down, has preserved them sound after 24 years exposure

Vitrified Earthen pipe has been patented to encase timber, the intervening space being filled with a grout of hydraulic cement. But after a first success the pipes were displaced and broken and the process abandoned.

On a ten-mile strip of track in the Union Pacific R. R. through Wyoming Territory, it was discovered sometime ago that the ties did not decay at all. A cottonwood tie, which in other localities will only last from 2 to 5 years, was found perfectly sound and harder than when laid, after 14 years use. An analysis of the soil shows large quantities of sodium, potassium, chloride, calcium and iron, with much organic matter.

Foremanizing is a patented compound of salt, arsenic and corrosive sublimate applied as a dry powder in 2 inch holes bored 4 feet apart in the timber; or putting between the layers of freshly cut lumber and shingles the dry powder in the ratio of 20 lbs. to 1000 feet B. M. The results of the use of this process were disastrous. Men employed in covering a roof with shingles thus treated were all made sick and one died; and when used in ties on ten miles of the Memphis & Charleston R. R., the cattle licked the compound exuding from the ends of the ties for the salt in it, and died in great numbers. The R. R. company was compelled by the farmers to take up and burn the ties, and the "foremanizing" company was cast in heavy damages and went out of the business.

Decay of Timber. On this subject the committee say that decay originates with the sap, which varies from 35 to 55 per cent. of the whole, when the tree is felled. The woody fibre alone will not decay, but when associated with the sap fermentation takes place in the latter and acts upon the fibre. The conditions of decay are, the presence of elements or germs of fermentation when exposed to air and moisture; there must be moisture to promote fermentation; there must be air present to oxidize the resulting products, and the temperature must be approximately between 50° and 100° F. Below 32° and above 150° decay does not occur.

Selection of Preserving Process. The committee said that the method to be selected for preserving wood, depends wholly upon its proposed subsequent exposure, and that it is a mistake to look to a single process for all purposes.

If the timber is to be put into sea-water and be exposed to the attack of the *teredo* or similar marine worms, creosote or "dead oil" is the only antiseptic in their knowledge; and the amount of this oil used depends on the situation and consequent temperature of the water as already mentioned. The quality as well as the quantity of the oil is important.

For railroad ties, creosoting is undoubtedly the best process, but owing to its expense it may be preferable to use a cheaper process. In England sleepers of Baltic fir 9 feet long and 10 × 5 inches, cost generally about 90 cents each, unloaded, grooved and piled; creosoting adds about 24 cents, so the sleeper costs $1.14 ready for the track, and is then laid with a chair so that it does not cut. It lasts therefore 18 to 20 years, while in this country they would be probably cut into by our rail in 12 to 16 years. As the first cost of our corresponding timber, hemlock or mountain pine, is only from 25 to 35 cents, we cannot afford to spend an equal amount in creosoting them, with the process more expensive here than in England.

The committee believe burnettizing to be the advisable method of tie-preservation in this country.

If the timber is to be exposed in a comparatively dry situation, as in bridges, trestles, or a fence, kyanizing is a good process to use.

Conditions of Success. The committee give the following as the principal conditions to be observed to achieve success:

Select the appropriate process in view of the subsequent use.

Select the more open-grained, porous and sappy varieties of wood to operate upon.

Operate on the cheaper woods, they can be better treated and can be made to outlast the best wood, in their natural state, by thorough treatment.

Extract the sap and water as far as practicable before injecting the preservative, as a place must be first made for this liquid.

Put in enough of the antiseptic to accomplish the desired result, of such quality and strength as will neither injure the fibre of the wood or leave it unprotected.

After preparation allow the wood to dry as much as possible before using, it will increase its durability.

Let there be no undue haste in the process. This is sure to give unsatisfactory results.

Protect the prepared ties, when possible, from moisture in laying, by draining the roadbed.

Contract for the work with none but reliable parties. Any inspection short of analysis does not fix the quality of the work. The safe course is, either to do the work yourself under the supervision of experts; contract at sufficient price with honest and skillful parties, or contract the work on such terms that the profits will depend on the results accomplished in preserving the wood from decay.

Will it Pay?—This question is answered very positively in the affirmative in Europe. In this country wood preservation is in an experimental stage, but the time has arrived when in many sections an economy of from 20 to 50 per cent. will result from the preservation of cross-ties and timber structures; while in other sections timber is still too cheap to warrant the expense of treating.

All depends on the cost. Where a white oak tie costs 25 cents and lasts 8 years, if we spend 25 cents more in preparing it so it will last 16 years, the only economy is in the expense of taking up a worn-out tie. But if this oak tie costs 75 cent and we can substitute a hemlock tie, which unprepared would last 3½ years, and costs 30 cents, and by treating it extend its life to 12 years at an additional cost of 25 cents, we have a marked economy in first cost and duration.

With piles likely to be attacked by the *teredo*, and, as in Southern waters, be cut off in one or two years, creosoting *must* be resorted to to avoid great waste of capital, In the Northern waters, where such piles last 8 or 10 years, the value of the structure resting on the piles must determine the question of artificial preservation.

In the case of bridges and trestles, much depends on the exposure, cost of maintenance, and abundance or scarcity of suitable timber in the vicinity. In the case of floors, etc., the ordinary wear from traffic must be taken into consideration.

As to actual money saved by treating timber, Privy Councillor Funk, of Germany, estimates in 1878, that out of the 60,000,000 sleepers on German railroads, 25,000,000 were impregnated, and that even by allowing 13 years life for oak and 6 years for fir and pine unprepared, an economy of about $1,000,000 would have resulted from preparing all the sleepers.

Regarding metallic ties the committee believe the time has not yet arrived when they can be profitably introduced into this country. They will cost, laid in the track, $2.50 each, and even if they last forever (the German estimate of life of a metal tie is from 29 to 40 years) the interest on the cost at 5 per cent. would be 12½ cents per year per tie, or more than the annual charge of an unprepared white oak tie costing 77 cents in the track and lasting 7 years.

The committee figure the relative economy of prepared and unprepared ties in this country as follows: Taking first, white oak costing 50 cents and lasting 8 years unprepared, and hemlock costing 25 cents and lasting 4 years, and estimating that it costs 25 cents each to treat them, and this increases the life of the first to 16 years and the last to 12 years, the annual economy in using 15,000,000 oak ties and 20,000,000 hemlock ties is $651,042. But if the oak tie costs 75 cents and the hemlock 30 cents, and the cost of treating and the number and duration were the same, the annual economy would then be $1,065,083. The interest account is not figured in the foregoing, and the cost of periodical renewals is omitted. The first item would increase the

cost as against the prepared tie, the latter as against the unprepared tie.

The voluminous appendix to the report is about equal in bulk to the report itself; and, while it is likewise valuable in its detail, space forbids anything more than a bare list of these appendices as given below, and the student must consult the original document for further information on this important subject.

APPENDICES.

1.	Preservation of Forests	F. Collingwood.
2.	Kyanizing	J. B. Francis.
3.	" on Eastern R. R	H. Bissell.
4.	Experience on Vermont Central R. R	J. W. Hobart.
5.	Experience on Boston & Albany R. R	E. S. Philbrick.
6.	Experience in Germany	—— Funk.
7.	Experience on Chicago, Rock Island & Pacific R. R	M. Alexander.
8.	Experience on Lehigh & Susquehanna R. R	L. L. Buck.
9.	Experience at Havre de Grace	E. Larkin.
10.	Description Thilmany process	O. Thilmany.
11.	Description Wellhouse process	J. P. Card.
12.	Description Gypsum process	T. Plate.
13	Creosoting on New Orleans & Mobile R. R	J. W. Putnam.
14.	Creosoting in general	E. R. Andrews.
15.	Creosoting on Houston & Texas Central R. R.	M. G. Howe.
16.	Boucherie process in Europe	E. Pontzen.
17.	Economy of Burnettizing on N. Y., L. E., & W. R. R	O. Chanute.
18.	Economy of creosoted ties	E. R. Andrews.
19.	Economy of preserving timber	B. M. Harrod.
20.	Formulæ for computing economy of R. R. ties	Ashbel Welch.

"The Co-efficient of Friction of Air Flowing in Long Pipes."*

BY PROFESSOR WILLIAM CAWTHORNE UNWIN, B. SC., M. INST. C. E.

The value of the co-efficient of friction of air flowing through long pipes is very imperfectly known. During the discussion of the Paper by Messrs. Culley and Sabine, the author deduced from their experiments the value $\delta = 0.007$ for air flowing, approximately isothermally, in lead tubes $2\frac{3}{4}$ inches in diameter.[1] Since that Paper was published the author has become acquainted with two series of experiments on the flow of air, carried out on a much larger scale, and furnishing a value of the co-efficient of friction more reliable for general application.

In the "Cours d'Hydraulique" of M. Phillips, p. 300, there are given the results of some experiments on the flow of air by M. Arson. The co-efficient of friction was found to vary sensibly with the velocity, and M. Arson adopted the well-known expression—

$$\delta = \frac{a}{v} + B$$

for the co-efficient of friction, in which a and B are constants and v is the velocity of the air in feet per second. Reducing M. Arson's results to foot and pound units, the following values of a and B are obtained for cast-iron pipes:

Diameter of Pipe. Foot.	a	B	δ for 100 feet per sec.
1.64	0.00129	0.00483	0.00484
1.07	0.00972	0.00640	0.00650
0.83	0.01525	0.00704	0.00719
0.338	0.03604	0.00941	0.00977
0.266	0.03790	0.00939	0.00997
0.164	0.04518	0.01167	0.01212

It will be seen that at velocities exceeding 20 or 30 feet per second, the first term $\frac{a}{v}$ in the expression for δ is small. On the other hand δ varies very greatly with the diameter of the pipe, as is known to be the case with water.[2] If an expression for the co-efficient of air is used, similar to that adopted by Darcy for the friction of water,

$$\delta = a\left(1 + \frac{B}{d}\right),$$

where a and B are constants and d is the diameter of the pipe, then M. Arson's results, calculated for 100 feet per second, would agree fairly well with the value

$$\delta = 0.005\left(1 + \frac{3}{10\,d}\right),$$

differing from Darcy's value for the friction of water only in the last term, which in any case is not large, except for small pipes.

For the tubes of the Post-office pneumatic system, $2\frac{3}{4}$ inches, or 0.182 foot, in diameter, this gives:

$$\delta = 0.0048\left(1 + \frac{3}{10 \times 0.182}\right) = 0.0127.$$

The difference between this and the value 0.007 found for the pneumatic tubes is probably due to the different surface of the smooth lead pipes in the one case and the rough cast-iron in the other. But under any circumstances M. Arson's experiments are valuable, as showing distinctly the influence of the diameter of the pipes on the co-efficient of friction.

Recently M. E. Stockalper has published the results of some observations on the flow of air in the pipes laid in the St. Gothard tunnel.[3] M. Stockalper has used the results to show, that Darcy's formula for the flow of water can be employed to calculate the flow of air, by merely multiplying the result by the ratio of the density of air to that of water. It is clear, however, that any formula of the form of Darcy's can only be approximate when applied to air, because it neglects the work due to the expansion of the air. It seemed therefore worth while to recalculate M. Stockalper's results by a formula strictly applicable to an expansible fluid.

The following table gives the results obtained by M. Stockalper on the flow of air through pipes 0.656 and 0.492 foot in diameter.

Experiment.	d Diameter of Pipe.	l Length of Pipe.	W Weight of air Flowing per Second.	Mean velocity.	p^1 Pressure at beginning of Pipe.	p^2 Pressure at end of Pipe.	T Mean absolute Temperature.	δ
	Foot.	Feet.	lbs.	Feet.	lbs. per Sq. Ft.	lbs. per Sq. Ft.	Fahr.	
I.	0.656	15,092	2.669	19.32	11,852	11,090	531	0.00347
	0.492	1,712.6	2.669	37.14	11,090	10,582	540	0.00451
II.	0.656	15,092	1.776	16.30	9,207	8,741	531	0.00375
	0.492	1,712.6	1.776	..	?	?	..	..
III	0.656	15,092	1.483	15.58	8,127	7,725	531	0.00410
	0.492	1,712.6	1.483	29.34	7,725	7,503	540	0.00447
				Mean for 0.656 foot pipe.				0.00377
				Mean for 0.492 foot pipe.				0.00449

The larger pipes were partly of cast, partly of wrought-iron, with flange joints and india-rubber joint rings. The smaller pipes were of wrought-iron, the joints being of the same kind. M. Stockalper's numbers have been reduced to pound and foot units.

The co-efficient of friction has been deduced by the formula, given in the Minutes of Proceedings Inst. C. E. vol. xliii., p. 271,

$$\delta = \frac{0.611^2\, d^5}{4\, W^2\, l\, T}(p_1^2 - p_0^2).$$

These results again show that the co-efficient of friction diminishes with an increase in the diameter of the pipe. They agree well with the formula

$$\delta = 0.0027\left(1 + \frac{3}{10\,d}\right),$$

which differs from that obtained in M. Arson's experiments in giving a smaller value of δ. This expression would give $\delta = 0.00393$ for the 0.656 foot pipe, and $\delta = 0.00435$ for the 0.492 foot pipe. Also for the $2\frac{3}{4}$ inch tubes of the pneumatic system

$$\delta = 0.0071,$$

almost identically the same as the value derived from the experiments on those tubes. It should be mentioned that the temperature of the air rose from 17° to 28° Centigrade during the passage of the air through the whole length of pipes. This rise of 11° was due to conduction through the pipe walls. It would, to some extent, have the effect of reducing the value of δ, the loss of pressure being really less than the pressure lost in friction.

The results found by M. Stockalper would seem to merit confidence from the large scale of the experiments and the means available for securing a regular flow of air. That they show a much smaller frictional loss than had been inferred from previous experiments, he has already pointed out; and he has also remarked on the importance of this in the application of compressed air, in such works as those at St. Gothard.

The great influence of the diameter of the pipe on the co-efficient of friction seems also to explain the difference between these results and those of Weisbach. Weisbach had given for the co-efficient of friction of air values ranging from 0.012 to 0.028, or values from four to seven times as great as those obtained by M. Stockalper. Weisbach's experiments were made on small tubes about 20 metres long, at velocities of 80 to 490 feet per second, and therefore the results do not merit great confidence. Still if the very small diameter of the tubes is allowed for, they diverge much less from M. Stockalper's results than they appear to do at first. The following table contains a comparison:

	Diameter of Tube. Inch.	δ by Experiment.	δ by Formula above.
Brass and glass tubes	0.400	0.014 to 0.027	0.027
Brass and glass tubes	0.564	0.012 to 0.026	0.020
Zinc tubes	0.960	0.013 to 0.023	0.013

*From Proceedings of the Institution of Civil Engineers.

[1] *Vide* Minutes of Proceedings Inst. C. E., vol. xliii., p. 270. The δ in that Paper is four times the quantity usually termed the co-efficient of friction. In this Paper it has been considered best to use δ in its usual sense.

[2] *Vide* Minutes of Proceedings Inst. C. E., vol. xliii., p. 271.

[3] "Expériences faites au Tunnel de Saint Gothard, sur l'écoulement de l'air comprimé. Par E. Stockalper. Genève, 1879.

American Woods.

Lignum vitæ stands first among our native woods in power to resist "indentation," which means in the census tests compression in a line perpendicular to the fibre. A punch one centimeter square was used and the force required to press this line into the wood to a depth of 1.27 millimetres was recorded. With lignum vitæ this force was 793 kilograms. The next ten species arranged in order of their power of resistance, belong, as does the first, to semi-tropical Florida, and the first wood on the list which is commonly known in the Middle States is the persimmon, ranking No. 32. The hardness of persimmon wood as compared with lignum vitæ, however, is only as 324 to 793. Osage orange offers a resistance of 363 kilograms; mahogany, 308; shagbark hickory, 271; sugar maple, 257; black birch, 227; white oak, 213; black walnut, 196; black ash, 194; white maple, 181; white ash, 171; American elm, 170; liquid amber, 132; tamarack, 112; Douglas fir, 100; hardy catalpa, 86, tulip tree, 82; aspen, 80; redwood, 77; white pine, 74; bass wood, 63.

The Effect of Sand Upon the Strength of Cement.

BY H. AENOLD.

Translated for ENGINEERING NEWS from the Transactions of the Society of Architect sand Engineers of Hannover, 1885, p. 495-500, by GEO. J. SPECHT, C.E.

The strength of mortar is influenced not only by the quality of the cement, but also by the quality of the sand used. The importance of sand in the formation of cement-mortar has been under-estimated. The rules and regulations usually applied in contracts, demand simply, that the sand shall be as clean and sharp as possible. It is not sufficient to stipulate that the sand shall be clean, quartz-sand, sifted until reduced to certain sized grains. The cleanness of the sand, and the size of the single grains have a great influence upon the strength of the cement. It will be of interest to study the results obtained in 1877 at the German harbor, Wilhelmshaven.

The sand used is found in the immediate neighborhood, and is called Dangast sand. The samples were made with all possible care, and chiefly according to rules, but never showed the same strength as those made at the naval station of Kiel, and at the imperial test-station in Berlin. The differences varied from 60 to 140%. The cause of this was found to be the different properties of the sand used. All the cement delivered by the manufacturers, and made into mortar with Dangast sand, showed this difference, although the manufacturer guaranteed a greater strength. For instance, a testpiece, (mixture 371) showed after 7 days, a tensile strength of 84.16 lbs., after 28 days 93.67 lbs., which is 11% increase. The contract stipulated a strength of 141.93 lbs.; the contractor promised 212.90 lbs. after 28 days. The cement was not accepted. The manufacturer, however, stated that he had obtained 204.32 lbs. after 7 days, where Berlin standard sand was used, and proposed to submit his cement to the imperial department for testing building material. This was agreed to. The trials made there, using Berlin standard sand, showed a tensile strength of 149.90 lbs. after seven days, and 207.87 after 28 days, or 78%, respectively 129% more than found at Wilhelmshaven. To check these trials a sample of the cement and a sack of Dangast standard sand was sent to the cement factory for the purpose of making their own trials. They obtained, with Dangast standard sand, 160.10 lbs. after 7 days, and with Berlin standard sand 238.45 lbs., which is a difference of 49%. The factory then sent a sack of their Berlin standard sand to Wilhelmshaven, where trials gave these results:

Made with Dangast standard sand, after 7 days, 128.60 lbs., after 28 days, 131.80 lbs.; mortar with Berlin standard sand after 7 days, 202.11 lbs., and 261.73 lbs. after 28 days; therefore difference between Berlin and Dangast sand 57%, respectively 89%.

The trials of 7 days correspond quite well, the factory's figures are a little higher on account of a different mode of making the testpieces. The increase in strength from the 7th. to the 28th. day, is in the last case with Berlin sand 29.5%, and with Dangast sand 7.5%.

Many more trials corroborated these results. They lead to the conclusion, that the quality of the sand affects to a large extent not only the initial strength, but also the percentage of increase. All the above trials have been made with standard sand, which means that the sand has been sifted several times until the grains were all of a certain uniform size, and has been cleaned by washing off all dust and particles of clay. The results obtained led to a more extensive investigation with different kinds of sand. The cement used in all trials was taken from one sack, so that the results were influenced only by the sand used. The different kinds of sand tried have the following qualities:

No. 1. Common Dangast sand, weight per quart, dry measure, poured out from a height of 0.82 ft. = 3.41 lbs., size of grains very mixed somewhat dusty, does not feel very gritty and sharp.

No. 2. Common Dangast sand; same as No. 1. but sifted, containing no gravel, feels less sharp.

No. 3. Standard Dangast sand; produced from No. 1, according to rules, mentioned above; weight, 3.19 lbs.; grain even, reddish color, not very sharp. The edge of the quartz particles are rounded off as shown by microscope.

No. 4. Common blue sand of Wilhelmshaven; very sharp and exceedingly fine sand, its blue color is caused by indirect effect of the fire, densely packed with grains of quartz, which can be ascertained easily by microscope. The sand is taken from pits 16′ below low tide, contains very few soluble ingredients and weighs 2.64 lbs. per one quart measure.

No. 5. Sand from the dunes on the island Wangeroog, similar to No. 4, but a little coarser, still a very fine sand; very gritty, free of dust and very clean, weight 3.43 lbs.

No. 6. Standard sand from Berlin, a sharp, fine, whitish quartz sand, grains of uniform size, weight, 3.61 lbs.

When mixed in the proportion of 1 part of cement to 3 parts of sand, the different mortars had the following strength:

SAND USED.	After 7 Days.	After 28 Days.
	LBS.	LBS.
Blue sand of Wilhelmshaven	101.48	133.42
Standard Dangast sand	124.62	157.55
Dangast sand No. 2	127.45	159.92
" No. 1	164.64	184.51
Wangeroog sand	193.39	237.53
Standard Berlin sand	243.37	311.41

These figures prove that the strength of different mortars made of equal proportions of sand and cement, using the same cement but different kinds of sand, depends upon the roughness and size of the grains of sand. If several kinds of sand have grains of the same size, that kind is the best where the grains are the roughest, the difference being about 100%. (Compare tests of Berlin and Dangast standard sand.)

In order to ascertain the influence of the size of the grains, different kinds of Dangast sand No. 1 were tested; proportion of mixture; 1 cement and 3 sand. Trials were also made with refuse of Swedish granite, used in buildthe docks. The same was separated according to different sized grains, the same as the Dangast sand.

No	Size of Grain.	Tensile Strength of the Mortar containing Dangast sand after.		Fine Granite refuse after	
		7 Days	28 Days	7 Days	28 Days
		lbs. per square inch			
1	Hazel-nut				
2	Peas				
3	Pealed barley	177.13	213.18	194.13	255.48
4	Oatmeal	162.37	191.33	175.79	233.91
5	Standard size	130.86	176.86	163.79	241.57
6	Seed of garden grit	134.27	163.51	143.64	192.26
7	Grass	141.08	160.10	135.70	193.19
8	Coarse dust }	63.59	87.41	87.15	133.70
9	Fine dust }				

TABLE GIVING THE PROPORTIONAL CONSTITUENTS OF THE SAND USED.

No.	Description of Seive.	Size of the grain of sand	Kind of Sand.	a. Dangast Sand No 1 per cent.		b. Wangeroog sand per cent.		c. Blue sand of Wilhelmshaven per cent.	
1	Small stones, selected by hand	hazel-nut	Gravel	0.7		.....		.....	
2	Remainder in sieve with 3 m m. holes	Peas	Gravel	2.0	2.7	.....	.....	.....	.....
3	Remainder in sieve with 2 m.m holes	Peeled barley	Coarse sand	4.0		.....		.....	
4	Remainder in sieve with 60 holes per 10 sq. centimeter.	Oatmeal	Coarse sand	13.5	40.5	.....	.....	.....	.....
5	Remainder in sieve with 120 holes do.	Standard size	Coarse sand	23.0		.....		.....	
6	Remainder in sieve with 200 holes do	Seed of garden grass	Fine sand	17.3	43.3	0	85	.....	.....
7	Remainder in sieve with 900 holes do	Grit	Fine sand	26.0		85		0	
8	Remainder in sieve with 5000 holes do.	Coarse dust	dusty of sand	9.5	13.5	15	15	55	100
9	Sand passed through last sieve.	Fine dust	dusty of sand	4.0		0		45	
				100.0		100.0			

This shows that between sands of equal roughness that, having the largest grains, is the best, of course, within certain limits. Roughness is of greater influence upon the quality of the sand than the size of the grains. For instance, the mortar made with sharp sand from Wangeroog has a strength after 28 days 50 % larger than that made of Dangast sand of equal sized grains. (No. 7 in table.) The proper number of Dangast sand to obtain the same strength as Wangeroog sand would have been No. 3.

The mortar made of the exceedingly fine, but very sharp blue sand has a 50 per cent. greater strength after 28 days than those made of Dangast sand No. 8 and No. 9. The corresponding Dangast sand would be No. 7.

Trials were made with Dangast sand No. 1, after separating the different sized grains by a sieve. The results were:

Size of grains (Referring to table above.)	Kind of Sand.	Tensile Strength of the sand after 7 days	Tensile Strength of the sand after 28 days
No.		lbs per sq. inch	lbs per sq. inch
2-5	Coarse Dangast sand	185.93	228.47
2-7	Dangast sand No. 1 free of dirt	177.41	198.43
2-9	Dangast No. 1	164.64	184.51
6-9	" very fine	110.99	147.89

This shows conclusively, that a better result can be obtained with a coarse grained sand free of dust, than with fine grained, both equally sharp; also, that the fine dust sand affects the mortar unfavorably, because it fills the spaces which should be filled by cement. It is further proven, that a sand of equally sized grain is not always the best, as the common Dangast sand No. 1, with sand furnished better results, than the Dangast standard sand, sifted and washed, of equally sized grains.

The influence of the sand upon the strength of mortar, does not only depend upon the amount used, but first of all—provided clean sand is used—upon the character and mixture of its grains. Different kinds of sand furnish very different results in mortars of equal composition. It cannot be said that a mixture of 1:5 or even 1:7 will be as good as one of 1:3. The quality of the sand to be found at the place where the mortar shall be used, must be taken into consideration.

IT is often asked, What is the best disinfectant for a cesspool? Two pounds of copperas, or sulphate of iron, dissolved in a pail of water, will greatly assist in purifying a privy or cesspool. A pound of nitrate of lead dissolved in the same way is excellent for sinks, drains or vaults. Chloride of lime is also effectual, or a layer of charcoal dust will prevent offensive odors arising from any decomposing substance. The quantity of these substances will depend upon the amount of filth to be deodorised, and the length of time during which they will be effectual will depend upon local conditions.

MAN has a various nature, which requires a variety of occupation and discipline for its growth. Study, meditation, society, and relaxation should be mixed up with his physical toils. He has intellect, heart, imagination, taste, as well as bones and muscles; and he is grievously wronged when compelled exclusively to drudgery for bodily subsistence.

OUR MATHEMATICAL COLUMN.

BY AN arrangement with the American publishers, Macmillan & Co. of London, have issued for the English trade a special edition of Merriman's text-book on the Method of Least Squares.

FLATLAND is the title of a curious mathematical novel lately published by Roberts Brothers of Boston, which in a very interesting manner attempts to give some idea of the theory of four-dimensional space, by narrating the experiences of a being who lived in two-dimensional space.

ONE of the problems in an ancient Hindoo text-book reads as follows:—"Of a flock of ruddy geese, ten times the square root of the number departed for the Manasa lake on the approach of a cloud: an eighth part went to the forest of Sthalapadminis; three couples were engaged in sport on the water, abounding with delicate flowers of the lotus; tell me quickly, dear girl, the number of the flock."

THERE has undoubtedly been a great increase in the power of mental calculation during the last two centuries. Napier's bones would be of no assistance to any one who knew the multiplication table as far as nine times nine. Even as late as Dabol's time the pupil was taught to substract with a vocal accompaniment like this: "I have to subtract 369 from 823; 9 from 3 I cannot, and add 10; 9 from 13 leaves 4; 6 and the 1 I borrowed are 7, 7 from 2 I cannot," etc. With a binary system of arithmetic all computations could be effected with less mental fatigue, and in less time than by the decimal system.

MATHEMATICAL probability is a measure of the degree of our mental confidence or belief. Zero denotes impossibility, and unity denotes certainty, and between these limits there is an infinite number of degrees of mental confidence. If a cent be thrown the probability that it will turn up head is ½, and that it will turn up tail is also ½. Now if a cent be thrown three times and each time turns up heads, what is the probability that it will turn up head the next time? To a person who knew nothing about the three throws the probability would be ½, but those who know of the previous circumstances would say that the probability is higher than ½, for they would naturally think that there was some peculiarity in the coin, or in the manner of throwing, which favored heads. Thus we see that the probability of an event about to occur may be different to different persons.

IT IS said that the Indian mathematician Sessa, the inventor of the game of chess, was ordered by the king of Persia to ask as a recompense whatever he might desire. Being well acquainted with numbers, Sessa only requested to be given one grain of wheat for the first square of the board, two for the second, four for the third, and so on, doubling each time to the sixty-fourth square. The king, well pleased with the modest demand, ordered his wise men to compute the amount, and on adding up the series 1+2+4+8+ etc., to sixty-four terms, they found that 18,446,744,073,709,551,615 grains of wheat would be required. Allowing that 9,216 grains made a pint, we find 31,274,997,411,295 for the number of bushels, which is several thousand times the annual wheat production of the whole world. The Arabian historian Al Sephadi, who started this story, omits to mention what the king said after his wise men had made the computations.

BENJAMIN FRANKLIN devised in 1755 a remarkable magic square, concerning which he wrote to Peter Collinson as follows: "Mr. Logan then showed me an old arithmetical book, in quarto, wrote, I think, by one Stifeluis, which contained a square of 16, that he said he should imagine must have been a work of great labor; but if I forget not, it had only the common properties of making the same sum, viz. 2056, in every row, horizontal, vertical and diagonal. Not willing to be outdone by Mr. Stifeluis, even in the size of my square, I went home, and made, that same evening, a magical square of 16, which besides having all the same properties of the foregoing square, had this added, that a four square hole being cut in a piece of paper of such a size as to take in and show through it just sixteen of the little squares, when laid on the greater square, the sum of the sixteen numbers so appearing through the hole, wherever it was laid on the greater square, should likewise make 2056. I make no question but you will readily allow this square of 16 to be the most magically magical of any magic square ever made by any magician." This famous square contains the natural numbers from 1 to 256, there being 16 in each vertical row and 16 in each horizontal row.

ANSWERS TO CORRESPONDENTS.

L. C. R.—The British yard and the United States yard are legally and practically of the same identical length. The statement in Webster's dictionary under the word *meter*, to which you refer, is simply erroneous.

M. B.—Professor De Volson Wood and Professor A. S. Hardy, are the two American authorities on the subject of quaternions. Some ten years ago we heard a great deal about the powers and possibilities of the quaternion method, but now a decline seems to have set in.

OSCAR.—Zerah Colburn, the famous lightning calculator, was an uncle of the founder of *Engineering*, who bore the same name. The wonderful feats of the calculator were performed in his youth, and as he grew older and became educated, his mental powers of calculation gradually disappeared, so that the English nobleman who had hoped to benefit science by educating the boy, was sadly disappointed. The calculator was born in 1804 and died in 1834.

Philadelphia's New Charter.

Under its present complicated system of Government, the city of Philadelphia is managed by twenty-four departments; these expend $9,000,000 a year, and give employment to 5,000 persons. Under the new city charter, which goes into operation April 4, 1887, these departments will be reduced to nine, three of which will be directly under the control of the Mayor—the Departments of Public Safety, of Public Works, and Charities and Correction.

The Department of Public Safety will be under the charge of one director, appointed by the Mayor, who shall have charge of police affairs, the public health, the fire service, telegraph, erection of fire escapes, inspection of buildings, boilers, markets and food sold therein. Seven departments of our present city Government are to be consolidated, and placed under the control of one person, the Director of the Department of Public Safety.

The most important department under the new system is that of Public Works. This department will have charge of water and gas works; the grading, paving, repairing, cleaning and lighting of streets; the construction, protection, and repair of public buildings, bridges, and structures of every kind for public use; public squares; surveys, engineering, sewerage, drainage, and dredging, and all matters relating to the city highways, wharves and docks. Five of the most important departments of the city are to be consolidated and placed under the charge of the Director of Public Works.

The city gas works manufactured 2,557,678,000 cubic feet of gas during the year 1884; they carbonized 280,691 tons of coal, and received $3,677,042.68 during the year from sales of gas, coke, tar, etc. The 13,555 public lamps were supplied with gas without cost to the city, and notwithstanding this the profits arising from the operations of the gas works were $814,132.27 for the year 1884, with gas at $1.70 per 1,000 cubic feet. With the cost of supplying public lamps with gas, and lighting and maintaining them, added to the profits of the works, the profits would have reached $1,200,000 equal to six per cent. dividend on a capital of $20,000,000.

The Water-works yield an income of $1,760,716.92 a year, or a net profit of $1,086,000, equal to a six per cent. dividend upon a capital of $18,000,000. It will be seen from this what an enormous power is placed in the hands of the Mayor, who will be charged with making the appointments of Directors of Public Safety, Public Works, and of Charities and Correction.

The American Exhibition.

The summer of 1886 will see the productions of all the English-speaking countries of the world displayed in London in friendly rivalry. The Indian and Colonial Exhibition will take the place of the inventories, and near to it, at Earl's Court, a space of 22 acres will be covered with buildings and gardens filled with specimens of natural products, agriculture and manufacturers from the United States of America. Some months ago we announced the probability of such an Exhibition, but since then the scheme has greatly developed, and has now attained proportions that promise to make it a very formidable rival to the last of the present series of shows at the Horticultual Gardens. A limited company has been floated with a capital of £50,000, to guarantee the necessary funds, and many of the leading men in the States have been enlisted in favor of the enterprise. So successful have the promoters been that already the applications for space exceed the available area to be allotted, and the months before the list closes will see a very large addition. The allotments will be made on the principle of favoring those who offer a good display, and of rejecting all the inferior exhibits: the space will not be cut up into minute pieces, but those who are prepared to make good use of it will receive an ample portion.

A piece of land, exceeding an acre in area, has been reserved for the Art Department, and the National Academy of Design will use its best endeavors to make this department as complete as possible. A considerable portion of the main building, which will have a transept 1200 feet in length, is to be devoted to the exhibits of the principle states and territories. The material resources and characteristics, social conditions of the various parts of the vast territory extending from ocean to ocean, and from the Lakes to the Gulf of Mexico, will be exposed to the view of thousands of visitors who in spite of endless books of travel have the vaguest ideas of American life and manners.

The condition of localities famed for agricultural, grazing, mineral and manufacturing facilities will be shown, while the state of developement and the undeveloped resources of the various sections will be presented to the visitor in such a form as will enable him to establish a trustworthy basis for judgment as to their respective advantages. Amusement is to be by no means neglected, and ten or twelve acres of land will be devoted to gardens, in which there will displayed in climatic sequence American conifers, shrubs, and plants, including an avenue commencing with those found in the Northern and Eastern States, and ending with those of the Southern and Western States.

If one-half this programme be fulfilled the Exhibition must be a great success. At a time when trade is languishing, and it becomes more and more difficult for men to find an opening for their talents and industry, the resources of other countries become exceedingly interesting, and there is no place to which the Englishmen turn so naturally as to North America. And those who are securely settled at home will find an endless field for study in the manufactures that will be shown.

The dearness of labor has developed a class of machinery in the States almost unknown here, but which acquires special interest in the face of falling prices and foreign competition, and many who find a difficulty in holding their own may pick up more than one useful hint at the Yankeries.—*Engineering.*

SPARK ARRESTERS.—The Master Mechanics Association has declared that locomotive spark arresters are practically a failure; that although many of them work well when the engines are run slowly they choke up when a speed of forty miles or more an hour is attained. The avoidance of sparks and cinders, it was thought, was to be attained by the use of petroleum for fuel—a result which has long been attempted, but, as yet, it is claimed, has not been succesfully reached.

RAILROAD FREIGHTS.—Some facts regarding railroad freight are curious, as, for instance, it costs four cents per ton to unload tierces and twenty four cents to unload light boxes. The chief reason is that one can be rolled while the other must be handled. Iron beams cost $2.05 per car to unload with tackle and $5.61 without. It costs eighty-one cents per car to unload rolls of leather, but $5.76 per car for loose sides.

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The Suez Canal.

From the report of M. de Lesseps, made to the Company on June, 4, 1885, concerning the affairs of the Suez Canal, the following extracts are made:—

The receipts for 1884 were	65,408,294 francs.
The expenses in 1884 were	30,336,443 "
Profits	35,071,851 "

In this connection M. de Lesseps remarks that the traffic of the canal has increased in spite of the general commercial depression, political conflict, wars, etc., events which have reduced the income of the French railroad system 25 millions of francs, and on English railroads 10 millions of francs.

The works at Ismailia for water supply have furnished in the year, 364,716 cubic metres to the consumers at Port Said.

He says the present canal is equal in capacity to the annual movement of 10 million tons of freight. This capacity is to be increased and must be done in successive stages; according to present plans the material and work required for the first stage in the improvement will cost 94,000,000 francs; the total cost of the improvement is estimated at 209,000,000 francs, including the work on the fresh water canal to Ismailia.

The Metropolitan Water Company.

The often-referred-to perils of the "Dry Goods District" of New York and the appalling waste of private and public property that might follow a serious conflagration in that section has called out many schemes for its better protection. Neither the present nor the future Croton supply will give the relief required without a complete remodelling of the distribution system; and besides, in this day of great consumption, potable water is too expensive a commodity to be used in the extinction of fire when a cheaper fluid can be obtained.

In this emergency the Metropolitan Water Company has been organized to furnish water from the North or East River for fire and sanitary purposes solely. We know nothing of its promoters or of the means available to meet the expenditure demanded by its truly gigantic scheme; but from an engineering standpoint the plan seems perfectly feasible and well adapted to fulfill all the conditions of the case.

Briefly sketched, the project includes a water supply taken from a point in the rivers sufficiently removed from sewage contaminations; and three steam pumps, two of 750 horse-power, to pump this water from the receiving well into an elevated reservoir some where near 59th St., this reservoir to hold 12,000,000 gallons of water and to be either in the form of a brick and masonry tower 100 feet in diameter and 350 feet high, or a standpipe 80 feet in diameter and of the same height. From this central reservoir an ample and independent iron pipe distribution system will ramify into the city, furnishing water under this great head, either by direct pressure for some hours, or under the increased impulse of the powerful pumping machinery at all times ready for action. This machinery is to be in triplicate aggregating 1750 horse-power. On the line of this pipe system are to be located 6000 fire-hydrants with from two to four openings each.

These plans are claimed to have been carefully worked out in all their detail by John Lockwood, Hydraulic Engineer, with Hon. Wm. J. McAlpine, as Consulting Engineer, and we doubt not that with sufficient capital in hand the scheme could be successfully carried out, bold as it is.

But while the company proposes to construct these works at their own cost and put it into complete order, they condition this outlay upon a contract with the City of New York giving them for a definite time and at a specified price, to be agreed upon, an annual rental for each hydrant, such payment only to commence when the water is actually turned on.

We are inclined to regard the project *per se* in a very favorable light and as in strict accordance with the increased demands for water in this day. Paris has already recognized the folly from an economic standpoint of attempting to furnish water from one and the same source for domestic consumption and the no less important requirements for fire and sanitary purposes; and in our own city Fire Commissioner Purroy has very lately practically demonstrated the utility of a copious supply of water taken direct from the rivers in cleaning the streets of accumulated filth and for flushing sewers. For fire purposes any water, excepting such as is absolutely filthy, will answer quite as well as the purest Croton; it is quantity not quality that is wanted. To furnish the enormous quantity in a short time, through our Croton system, that a serious down-town fire might demand, means the practical relaying of our entire distribution system with all its connections and the increased waste of a more costly supply. It is certainly a sensible idea then to take the water intended for the extinguishment of fire, the cleaning and sprinkling of streets, the flushing of sewers and for hydraulic power if need be, from the inexhaustable supply flowing by our doors and at the minimum cost, and to reserve the more precious Croton for such uses only where the other would not apply. The first cost of such a division of supply would now be very great, but we believe it would be economical in the end.

The Future Water of Philadelphia.

Col. Wm. Ludlow, Chief Engineer of the Philadelphia Water Department, has lately given to the members of the Franklin Institute a concise statement of the results to date of the extensive and thorough examination into the extension and improvement of the water supply of that city now being made, We make the following abstracts from the July number of the *Franklin Institute Journal.*

The question of the future water supply of Philadelphia is an old one, but until very recently all estimates and proposed schemes have been practically futile from the want of exact data concerning the wide range of country from some part of which the supply must come. In 1883 appropriations were at last made by councils to cover the expense of making this survey in an intelligent manner, and Mr. Rudolph Hering, C. E. was put in direct charge. Since that date about nine-tenths of the territory to be investigated has been covered, including topographical and hydrographical surveys, meteorological observations, chemical analyses and sanitary inspection. The thorough and capable manner in which this work has been done by Mr. Hering is testified to by his Chief Engineer in the remarks quoted.

The two main points of available future supply are the Perkiomen and the Delaware valleys. The first is an old project, suggested many years ago by Mr. Birkenbine, then Chief Engineer. But the present investigations tend to show that the flow of that stream, even aided by some of its affluents, is insufficient for the near future demands of Philadelphia, which is estimated as at least 210,000,000 gallons daily.

In considering the Delaware valley as a source of supply, the discovery was made during the present surveys that a practicable conduit line 30 miles long could be built to the Delaware river at Point Pleasant, half-way between Trenton and Easton. On this line the waters of several considerable streams could be intercepted and sent to the city by gravity, in quantity sufficient for the greater part of the year, any deficiency to be made good by pumping from the Delaware. Both this conduit, and that of the parallel scheme in cost, the Perkiomen, would be 12 ft. in diameter, have a grade of 1 foot in 6000 ft. and a capacity of 210,000,000 gallons daily delivered at an elevation of 166 feet above city datum. The cost of either project is estimated at from $6,500,000 to $7,000,000. The volume of flow in the Delaware at Point Pleasant is 700,000,000 gallons per day, and the water is of excellent quality.

In estimating the quantity required Col. Ludlow stated that the present pumpage in Philadelphia is about 70,000,000 gallons per day. A generation hence he expects that city to have a population of two millions, and thinks it would be folly to project any plan contemplating a smaller daily supply than 200,000,000 to 210,000,000 gallons.

In speaking of the failure of the Schuylkill River to furnish an acceptable supply, he said that the population on its banks above Philadelphia is over 350,000, and the refuse matter of this population with their factories, mines, etc., is being poured into the Schuylkill. The flow of this river has also diminished in a marked degree within 60 years; this flow being estimated at 500,000,000 gallons in 1825 and in 1874 the minimum flow was 250,000,000 gallons. This apparent falling off in supply is charged to decrease in storage power due to the cutting down of forests, and cultivation of the land rather than to any diminished rainfall.

The Poetsch System of Shaft-Sinking by Freezing.

In ENGINEERING NEWS of July 5th, 1884, we gave an illustrated description of the Poetsch method of shaft-sinking through water-bearing formation by means of the freezing process; further points upon this interesting subject are now given from an article by J. Keller, M. E., in *Le Génie Civil*, of June 13, 1885.

The general description and history of the process is the same as that we have already published, but some further detail is presented regarding the sinking of the Emilia shaft, 8½ feet in diameter, through 115 feet of a water-bearing sand formation. Twelve cir-

culating tubes were used, sunk in a circle about 14 feet in diameter; from 12 to 15 days were required to sink these tubes a depth of about 100 feet. The tubes were given a very slight inclination outward at the bottom, to avoid any deviation in sinking that might interfere with the line of the shaft.

The freezing liquid employed was a solution of chloride of calcium, which congeals at a temperature of 35° C. (31° below zero Fahrenheit.) The circulation of the liquid through the tubes was made by a small pump with a piston 6 inches in diameter and 12 inches stroke. At the beginning of the operation this pump made 30 double strokes per minute, which was equivalent to the passage of $\frac{6}{10}$ gallons of the liquid through each tube per minute; at the end of the operation when it was only necessary to maintain the low temperature secured, the pump strokes were reduced to 15 per minutes. The refrigerating machine employed was one of a model guaranteed by the maker to produce 1100 pounds of ice per hour. The motive power was supplied by a small engine of about 5 horse-power. The ammoniac pump had a piston $2\frac{8}{10}$ inches in diameter and a length of stroke of $9\frac{7}{10}$ inches; it made 30 strokes per minute. The pressure maintained was about 10 atmospheres. The quantity of ammoniacal liquid necessary to charge the apparatus was 281 gallons. Under normal conditions the daily consumption of this liquid was .78 gallons.

The actual shaft excavation was commenced 53 days after the freezing apparatus had been set in motion. The work was done without difficulty, and a progress of $1\frac{84}{100}$ feet per day was made, paying the laborers $14.40 for each *metre* (3.28 ft.) of sinking. The timbering was very light, but no internal pressure of any kind was observed; the brick masonry used for finally lining the shaft was about 11 inches thick. The tubes were withdrawn without difficulty when the shaft was finished by circulating through them a hot instead of a cold solution of the chloride of calcium, thus thawing them loose from the surrounding ice. The tubes were entirely uninjured and could be used again in any other similar operation.

Without being able to obtain the exact figures of cost from Mr. Poetsch, the author of the paper, however, gives an estimate which he says very nearly approaches the actual figures.

He gives the cost of the plant for this particular piece of work as follows:

	Francs.
An ice-machine complete, of a capacity of 1100 pounds per hour	50,000
280 gallons of concentrated ammoniacal liquid	1,375
Chloride of calcium	1,500
1280 feet tubing, from $6\frac{5}{10}$ to $7\frac{5}{10}$ inches diameter	7,800
1280 feet " " $1\frac{5}{10}$ to 2 inches "	1,462
Distribution pipes	1,000
Lead tubes for branches 2640 pounds	180
26 valves on branches	650
4 main valves	400
12 caps to the tubes	600
Bolts and iron-work	1,000
Material for sinking tubes	7,500
Incidentals	1,233
(say $15,000)	75,000

The mounting and installation of the plant is figured as follows:

	Francs.
Foundation for the ice-machine	1,000
Mounting the same	2,000
Sinking 1280 feet of tubes, at 40 francs per *metre.*	15,000
Plugging the tubes at the bottom, labor and material	960
Fitting the pipe connections	1,500
Incidental	2,940
(say $4,800)	21,000

The daily expenses in conducting the freezing process is put down as follows:

	Francs.
2 machinists at 8 francs each	16
2 assistants at 4 " "	8
3 *litres* of the ammonical solution at 1.25 francs	3.75
Oiling, lighting, etc	3
Steam production	20
Incidentals	4.25
(say $11.00 per day.)	55

With these details at hand it is easy to fix upon the total expense. The work was commenced on the Emilia shaft on July 1, 1884, and was finished March 1, 1885; the freezing machine was therefore in operation 240 days. Mr. Keller estimates the cost of sinking the shaft at 150 francs per running *metre*, complete; and the masonry at 40 francs per cubic *metre*, or 80 francs per running *metre*. He counts the shaft proper finished as costing in round numbers 250 francs per running *metre*, not including the temporary timbering used.

The total expense he puts down as follows, allowing 25 per cent, for depreciation of plant.

	Francs.
Depreciation, 25 % of 75,000 francs	18,750
Expense of moving the machinery	5,000
Setting up and fitting	24,000
Service of the ice-machine, 240 days at 55 francs	13,200
Shaft-sinking and lining, 38 metres at 250 francs	9,500
Superintendence of work, traveling, etc	9,550
($20,000)	80,000

This amounts to 2,105 francs per running metre, or $128.66 per lineal foot.

The author in speaking of this novel process says that the work done at this Emilia shaft proves that it is perfectly practical and that it can be applied to any diameter or depth of shaft. It is particularly valuable in as much as it makes possible a *true* estimate of total cost before the work is commenced, a condition of affairs unattainable by any other known method in like difficult ground.

Cold may now be recognized as a *power* in the industrial world.

Civil Engineering Societies in the United States.

The following list of American Societies of civil engineers is based upon data obtained directly from the secretaries of the different organizations, and the membership is given as near by as possible to date. The Societies are ranked by date of original organization, though several of the older bodies were practically inactive for some years after their launch into being:

The Boston Society of Civil Engineers, organized July 3, 1848, incorporated April 24, 1851. Active Members, 118; Honorary Members, 6; Corresponding Members, 2; total, 126. Secretary, Horace L. Eaton, Boston, Mass.

American Society of Civil Engineers, instituted Nov. 5, 1852. Honorary Members, 9; Active Members, 676; Associates, 33; Juniors, 79; Fellows, 62; total, 859. Secretary, John Bogart, House of the Society, No. 127 East 23rd. Street, New York City.

Rensselaer Society of Engineers, organized Jan. 1866, incorporated May, 1873. Honorary Members, 13; Active Members, 112; Associates, 25; Juniors, 33; total, 183. Secretary, R. G. Turknett, 405 Broadway, Troy, N. Y.

Engineer's Club of St. Louis, incorporated April 12, 1869. Honorary Member, 1; Active Members, 120; total, 121. Secretary, Thos. D. Miller, 622 Locust Street, St. Louis, Mo.

Western Society of Engineers, organized May 25, 1869, incorporated Sept. 1, 1880. Members, 111; Associates, 9; total, 120. Secretary, L. P. Morehouse, Care Illinois Central R. R. Co., Chicago, Ill. This society was originally organized as the Civil Engineers Club of the Northwest, but was incorporated as above.

Engineer's Club of Philadelphia, organized December 17, 1877. Honorary Members, 3; Active Members, 399; Corresponding Members, 5; Associate Members, 6; total, 413. Secretary, Howard Murphy, House of the Club, No. 1122 Girard Street, Philadelphia, Pa.

Ohio Society of Surveyors and Civil Engineers, organized Dec. 2, 1879, incorporated, Jan., 1885. Honorary Members, 5; Active Members, 98; total, 103. Secretary, Benjamin Thompson, Urbana, Ohio. The original organization was entitled the "Association of the County Surveyors of the State of Ohio."

Civil Engineer's Club of Cleveland, organized Feb. 28, 1880. Honorary Members, 3; Active Members, 128; Associate Members, 4; Corresponding Members, 5; total, 140. Secretary, E. H. Jones, Cleveland, O.

Engineer's Society of Western Pennsylvania, incorporated March 20, 1880. Total Membership, 331. (The published list of members is without classification). Secretary, W. F. Zimmermann, 98 Fourth Avenue, Pittsburg, Pa.

Michigan Engineering Society, organized March 25, 1880, under the name of the "Michigan Association of Surveyors and Civil Engineers." Total Membership, 183. Secretary, Prof. R. C. Carpenter, Agricultural College, Lansing, Mich.

Missouri Association of Surveyors and Civil Engineers, organized Feb. 16, 1881. Total Membership 99; divided as near as we can ascertain as follows: Surveyors, 48; Civil Engineers, 36; Associate, 5, and Honorary Members, 10. Secretary, Prof. T. J. Lowry, University of the State of Missouri, Columbia, Mo.

Indiana Association of County Surveyors and Civil Engineers, organized March 2, 1881. Honorary Members, 11; Active Members, 64; total 75. Secretary, Lewis S. Alter, Rensselaer, Indiana.

American Water-Works Association, organized March 29, 1881. Active Membership, 135; Associate Members, 39; total, 174. Secretary. J. H. Decker, Hannibal, Mo. This association is devoted to the improvement of plant and method in all that pertains to waterworks construction and maintainance.

Engineer's Club of Minnesota, organized, April 30, 1883. Honorary Member, 1; Members, 37; total, 38. Secretary, Prof. Wm. A. Pike, State University, Minneapolis, Minn.

Civil Engineer's Society of St. Paul, organized December 21, 1883. Total Membership, 34; there are no Junior or Associate Members. Secretary, C. J. A. Morris, P. O. Box, 2,544, St. Paul, Minn.

Connecticut Association of Civil Engineers and Surveyors, organized Jan. 15, 1884. Honorary Members, 4; Active Members, 63; total 67. Secretary, D. C. Sanford, New Haven, Conn.

Technical Society of the Pacific Coast, instituted April, 1884. Membership unknown. Secretary. C.G. Yale, 414 Clay Street, San Francisco, Cal.

In addition to the above, we give more or less complete data concerning other engineering societies about which we have as yet been unable to obtain all the details.

Essayons Club at Willet's Point, N. Y. This club was organized about 1871 by Gen. H. L. Abbott, who was then in charge of the Engineer batallion and post at that point. It is composed of engineer officers only, and includes all who have been stationed with the batallion. Its range of subjects includes civil and military engineering, and the papers read are printed for distribution among the officers of the Engineer Corps. The Club at present seems inactive.

Technischen Vereins von New York. This is an association of German civil and mechanical engineers, architects and chemists; incorporated Oct. 20, 1883. According to its published list of members of Jan. 1884, it then had 288 members, 65 of these classed as civil engineers. and 163 of the total list resident in the United States, the remainder were scattered in Mexico, South America, etc. The Society aims at the encouragement and advancement of the Technical Arts and Sciences in all their branches, and the assistance of needy and newly arrived colleagues. At the time referred to the Secretary was Max C. Budell, 287 Broadway, New York. It publishes papers annually with its annual reports.

Nebraska Association of Engineers and Surveyors. Of this organization we know little except that it did exist, with headquarters in Lincoln, Neb. The Secretary is George W. Tillson, Omaha, Neb.

Denver Society of Civil Engineers. This Society was organized in 1882; the Secretary for 1885 if E. S. Davis of Denver, Col.

Engineering Society of the Students and Alumni of Lehigh University. The title of this Society sufficiently explains its purpose. It was organized about 1873, and has a membership of about 100. The Secretary was lately T. W. Birney, Bethlehem, Pa.

Civil Engineers Club of the University of Illinois. This is also a student's society. The present Secretary is H. B. Williams, care of the University, Champaign, Ill.

The New England Water-Works Association. This Society, organized June 21, 1882, is made up mainly of superintendents of water-works, and has for a purpose the same objects as those already stated for the American Water-Works Association. It now has 96 Active and 46 Associate Members. The Secretary is Albert S. Glover, West Newton, Mass.

With regard to publication of transactions and proceedings, the most important are those of the American Society of Civil Engineers, the Engineers Club of Philadelphia, and the Association of Engineering Societies. The last named is a union for publication purposes of the Boston Society, the Engineers Club of St. Louis, the Western Society, the Civil Engineers Club of Cleveland, the Engineers Club of Minnesota, and the Civil Engineers Society of St. Paul. The Technical Society of the Pacific Coast has a very creditable monthly publication of its own. The great majority of the other societies named publish their papers along with their annual reports.

In making out this list we have confined ourselves to those connected by title at least with the advancement of civil engineering; of surveyor's societies, pure and simple, there are a number not here named. In connection with any attempt to get at the aggregate of civil engineers as given in the membership of these various societies, we would caution our readers that many engineers belong to two or more of the societies at the same time. This is especially the case in the most important of all of these organizations, the American Society of Civil Engineers, which includes many members of local societies.

We will be indebted to our readers for any corrections or additions to our list as here given.

The Liverpool Engineering Society.

According to the Annual Report for 1884, the roll of this Society contains 5 Honorary Members, 1 Life Member, 98 Ordinary and 6 Student Members; a total of 110. The officers for 1885 are, President, W. E. Mills; Secretary, T. L. Miller, 19 Percy St. Liverpool. The place of meeting is the Royal Institution, Colquitt Street. During the year twelve papers were read, including the Presidents address. The income during the year was £101.6s.10*d*. The Society was established November 10, 1875.

PERSONAL.

FRANCIS A. WALKER, President of the Mass. Institute of Technology, has been offered the Presidency of Cornell University.

REUBEN N. RICE, for several years General Superintendent of the Michigan Central Railroad, died lately, at his home in Concord Centre, after a brief illness, aged sixty-five years.

CAPT. JOHN GRANT, Chief Engineer and General Manager of the Guatemala Northern Railroad, arrived in New Orleans, June 30th, from Central America, on the steamship Wanderer. He reports the work on his roads progressing rapidly.

Mr. J. A. McDuffie has been appointed General Freight and Passenger Agent of the Brunswick & Western R. R. He will also have charge of the Transportation Department as Master of Transportation and grain Despatcher.

MAJOR W. M. WALLACE, died in Montevallo, Ala., on June, 28th, aged 56 years, after a protracted illness of several months. He was a Civil Engineer, and held a position as Chief in locating the S. R. and D. division of the E. T., Va. and Ga. road.

MR. FRANK BREWER, C. E., in practice at 17 & 19 Broadway, this city, and for three years principal Assistant Engineer on the Ohio Valley Railways, has just received his diploma as an Associate Member of the Institution of Civil Engineers of London, England.

WINFIELD SCOTT CHAPLIN has been appointed professor of engineering in Harvard College. Prof. Chaplin has lately been at Union College. His new appointment is highly complimentary to his scholarship and it is very gratifying to his many friends in Bangor, Me.

MR. RICHARD J. EVANS, late Chief Engineer of the Memphis, Selma and Brunswick, and a Civil Engineer and Superintendent of wide experience in the South, has been appointed by the United States Court Inspector of the work done on that road under the Receiver, all the adverse interests approving his selection.

W. H. GAYS, has accepted the position of General Manager of the affairs of the Wiggins Ferry Combination Company, St. Louis. The company operate the two belt railroads on the East St. Louis side of the river, the belt road on the St. Louis side of the river, the Wiggins and the Madison company ferries.

MAYOR LOW of Brooklyn, has appointed as Commissioners to carry out the provisions of the underground wire law, George W. Plympton, Professor of Chemistry and Electricity in the Polytechnic Institute and editor of the *Electric Engineering Journal*; Rossiter W. Raymond, an electrician, and John Reynolds a lawyer.

MR. IRVING A. STEARNS, Mining Engineer, of Wilkes-Barre, Pa., has been appointed and confirmed by the Board of Directors to be manager of the several coal companies controlled by the Pennsylvania railroad, in place of Mr. C. B. Rossell, resigned, and will hereafter be charged with all the duties and authority imposed on that office by the respective by-laws and organizations of the said companies.

HENRY H. GORRINGE, late Lieutenant Commander U. S. N., died in New York on July 6, of spinal disease. Mr. Gorringe was born 44 years ago in Tobago in the West Indies, his father being a clergyman of the Episcopal Church. He entered the American merchant service when a lad; was appointed a mate in the U. S. Navy July 12, 1862, Acting Ensign October, 1862, and Acting Volunteer Lieutenant Commander in July, 1865; in Dec. 1868, he was made a Lieutenant Commander. He became famous in 1880 by successfully transporting and erecting, in Central Park, the Egyptian Obelisk, at a total cost of about $102,000. He resigned from the Naval Service about this time, owing to friction between himself and Mr. Chandler, then Secretary of the Navy, and in March, 1883, he started the American Ship Building Co., at Port Richmond in Philadelphia, but the enterprise was not successful and the company went into the hands of a Receiver last year. Mr. Gorringe was elected an Associate of the American Society of Civil Engineers, April 6, 1881.

COL. CHARLES G. WATERBURY, formerly a prominent contractor of New York, died on July 4th, after a week's illness. Col. Waterbury was born in Greenpoint, Long Island, in 1816. He received a common school education, and went into the lumber business in this city, in which he made a fortune. About 30 years ago he retired from the lumber business, and took a contract from the city to pave the Bowery. Since that time, with the exception of the period covered by the war, when he was in the Union Army, he has been prominent as a city contractor. He laid the first Belgian block pavement put down in this city, opened and graded First avenue and graded Eighth avenue. He was instrumental in forming the Nicholson Pavement Company, and was its President up to the time of his death. One of his most notable achievements was the removal of the Central Presbyterian Church, about eight years ago, from its old site at Fifth avenue and Ninteenth street to its present site on Fifty-Seventh street, between Broadway and Seventh avenue. The church was pulled down and rebuilt of the same materials, each stone being replaced in the same position it originally occupied.

At the outbreak of the war he raised a company in the Eighth New York Regiment and was made its Captain. He was at the battle of Bull Run, and served in the campaigns of the Army of the Potomac, raising step by step to the rank of Colonel. Latterly he had devoted his time principally to experimenting in the culture of fruit and gold leaf tobacco on a plantation which he purchased near Littleton, in Richland County, S. C.

CORRESPONDENCE.

Civil Engineers and Metric Measures.

NEW YORK, July, 7, 1885.

EDITOR ENGINEERING NEWS: The Convention of the American Society of Civil Engineers at Deer Park brought together as large an assembly of responsible engineers as has been at any time gathered, and the assemblage was eminently attentive to technical subjects. Including the President's address and the business meeting, in both of which professional subjects were under discussion, eight sessions were held and, as noticed by those interested, in only two instances were metric measures referred to, and in one of these it is evidently a quotation from the words of a chemist.

In this connection it would be of interest to know the reasoning that induced the Superintendent of the Census to print 137 4to pages of tabular matter on the "Strength of American Woods," containing about 40,000 results in terms of *millemetres* and *kilometres*.

It will be urged that a man who can not reduce metric to English measures is not fit to be an engineer; and undoubtedly most of us can do it, as we read French, i. e. with some labor, when the information sought justifies the trouble. No American engineer thinks in metric terms.

If the Government has expended the money necessary to procure and point the data given by the "Report on the Forests of North America" to furnish examples in reduction to boys in preparatory schools and colleges, its care for the gymnastic training of youthful minds merits praise, for it has succeeded in supplying a large mass of material that will be found to possess little other practical value. But if the money of our country has been squandered by a set of so-called "Metric Cranks" in an endeavor to force a system of foreign measures upon us, a system whose only advantage lies in their extreme inconvenience to the person who has to manipulate it, Congress should see that no more reports issue from that bureau, till it is made to comprehend that a book in the English language should be so written that English speaking people can read it without resorting to 40,000 arithmetical computations.

It gives me pleasure to notice that the report is not entirely without information that requires reduction to make it available. Though the heights and diameters of trees are given in *metres*, the elevation of the ground on which they grow is often in feet. In Table I we have the diameter of a tree again in *metres* but the weight of the wood is in pounds per cubic foot. In Table II we have the fuel value per cubic *decimetre* and per *kilogram* (giving a handy exercise for firemen in Civil Service examinations,) but the weights are again in pounds per cubic foot, and the statistics of the lumbering interests are in board measure and in dollars, instead of cubic *metres* and francs. Yours Truly,

EDWARD P. NORTH.

GLUE to resist heat or moisture is made as follows:—Mix a handful of quicklime in 4 oz. of linseed oil; boil to a good thickness; then spread it on tin plates in the shade, and it will become very hard, but may be easily dissolved over the fire as glue. A glue which will resist the action of water is made by boiling 1 lb. of common glue in 2 quarts of skimmed milk.

THE deaths registered last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 20.5 per 1,000 of their aggregate population, which is estimated at 8,906,416 persons in the middle of this year.—*Sanitary World*, June 13th.

The New Croton Aqueduct.

A. Fteley, the Executive Engineer of the New Croton Aqueduct, contributes the following description of this important work to *Science*, of June 19th:

The necessity for an addition to the present supply of water of New York has been felt for many years, and the present Croton Aqueduct, finished in 1842, has become entirely inadequate to meet the present requirements of the city. Never was the need of an additional supply better illustrated than in 1880, when the authorities in charge stated, at the end of a prolonged drought, that there was only fifteen days' supply at hand. Timely rains occured shortly afterwards, and replenished the water-sources.

Since 1875, when two projects were presented for an additional water-supply, numerous surveys were made, extending in several instances beyond the limits of the present collecting-grounds; and in the beginning of 1883 a committee of citizens, appointed by the mayor at the request of the Senate, presented to the Legislature a report recommending that provision be made for the ultimate storage of all the water from the Croton basin, and for the immediate construction of a new aqueduct.

This scheme is now being carried out by a commission created by the Legislature (May, 1883), and composed of the mayor, comptroller and commissioner of public works, and of three citizens at large.

The available watershed of Croton River covers now 338.82 square miles. Its waters are at present collected in several storage-reservoirs, the lowest of which, (Croton Lake) acts also as a settling-basin, from which the present aqueduct starts, and extends as far as the main distributing reservoir in Central Park. Owing to the limited capacity of the present storage-reservoirs and of the aqueduct, a very large proportion of the flow of the river is unavoidably wasted over Croton dam.

The present scheme consists in building reservoirs capacious enough to impound the copious spring flows, and in constructing a larger aqueduct, through which the necessary allowance of water can be drawn all the year round from the new reservoirs. It is consequently, in a general way, on a larger scale, a duplicate of the present system; but the very scale on which the work is to built gives rise (as may be understood from the short description which follows) to many interesting and difficult engineering problems.

It is estimated, that, in the dryest years, the Croton watershed can furnish a daily supply of 250,000,000 gallons, equivalent to 100 gallons per head per day for a population of two million and a half souls, or to 75 gallons per head for a population of three and one-third millions.

In order to store the large amount of water necessary to provide this large daily supply during the dryer months, it has been found advisable to provide, at first, one reservoir of very large capacity, placed low enough in the Croton valley to increase to 361.82 square miles the available area of the watershed of Croton River. This reservoir is to have a capacity of 3,200,000,000 gallons,—a body of water which would cover 9,400 acres ten feet deep.

The dam which is to form this reservoir (the Quaker-bridge dam), 178 feet high above the bed of the river, is to be built of solid masonry, and the water behind it is to be 171 feet deep. As the foundations of the dam must be extended to the bed-rock, a distance of nearly 100 feet below the bed of the stream, the total height of the masonry structure will consequently be not far from 300 feet for a length of 400 feet in the deeper portion of the valley. On both sides of this deeper portion the rock-bottom rises gradually, and the total length of the dam is to be about 1,300 feet.

The height mentioned for a masonry dam is unprecedented; and the strains which will be transmitted to the base of the structure by the combined action of its own weight and of the water-pressure are such as to require in the design a departure from the methods used and recommended by the engineering authorities who have studied the question of high masonry dams of lesser magnitude. The width of the dam at its base, although not fully decided upon, is to be more than 200 feet.

The question of providing an overflow to liberate the surplus water which must be wasted over the dam is happily and economically solved by nature, which has provided in the immediate vicinity a depression in the rock-formation, of the required elevation and form for the safe disposal of the freshets.

The new aqueduct starts from a point near the present Croton dam, and follows a general southerly direction towards the city, to 135th Street, with a length of nearly thirty-one miles. For the remaining distance, from 135th Street to the reservoir in Central Park (two and one-third miles), the water is to be conveyed in pipes. Harlem River is crossed by means of an inverted siphon 150 feet below the water surface.

With the exception of three points where it comes to the surface of the ground for short distances, the aqueduct is to be wholly in tunnel; and from the indications furnished by the topographical character of the country, and by numerous borings made with the diamond drill, it is probable that the excavation is to be, almost for the whole length of the aqueduct, in solid rock.

It is expected that a large proportion of the tunnel excavation is to be lined with masonry; but wherever the character of the rock is such that it can remain exposed without danger of falls, the masonry is to be dispensed with. If the line of the work had been so located as to allow of the construction of the aqueduct in open trenches of moderate depth, it would have been much longer, owing, to the necessity of following the contours of the land; and it would have passed along the east shore of the Hudson River, through thickly settled communities, where the land-damages would have been much higher. The tunnel presents also the important advantage of being almost wholly safe from the attacks of a mob or of a military foe.

From Croton dam to a point south of and near the boundary of the cities of Yonkers and New York, the aqueduct has a maximum flowing capacity of 320,000,000 gallons per day; it is 13.6 feet high and 13.6 feet wide; and its section is that of a semicircular arch, supported on slightly concave sides, the bottom being formed by a flat inverted arch,

At the point just mentioned where it is expected that a large distributing reservoir is to be built to supply the annexed district, and where consequently a portion of the supply is to be diverted, the flowing capacity of the aqueduct is reduced to 250,000,000 gallons per day, and its form is circular, with a diameter of twelve feet three inches.

This part of the aqueduct, over six and a half miles in length, including the inverted siphon under Harlem River, is to be heavily lined with masonry; and owing to the insufficient elevation of the land, it is depressed to a considerable depth, presenting the peculiar, and to a certain extent experimental, feature of a masonry channel built in solid rock, and subject to a considerable internal water-pressure. Its prototype, the tunnel under Dorchester Bay, which conveys the sewage of Boston to Moon Island, has been in successful operation for more than a year, but under somewhat different conditions of location, size, and pressures.

For the purposes of construction and of future maintenance of the aqueduct, thirty-two shafts are provided, of various depths, the greatest being 350 feet. Twenty-four shafts are under construction, twelve of which are already completed, or nearly so.

Six extensive gate-chambers are to be constructed, in connection with the aqueduct, for the purpose of emptying it when necessary, and of regulating the flow of water from the storage-reservoir into the city. One of them, at the head of the aqueduct, near Croton dam, is to be of unusual size, and is to be constructed to support a maximum pressure of 65 feet of water.

The aqueduct from Croton dam to Harlem River is now under contract to the amount of $11,900,000, The rest of the work is to be commenced shortly.

LITERATURE.

A Text-book on the Mechanics of Materials and of Beams, Columns and Shafts. By MANSFIELD MERRIMAN, Prof. of Civil Engineering at Lehigh University, New York, John Wiley & Sons, 1885, 8 vol. 152 pp. $2.00.

The subjects which are usually comprised under the title "Strength and Resistance of Materials" are treated in this book, the latest offspring of Professor Merriman's pen, although some of the topics are disposed of in a brief space. When we say that the work is a very good elementary text-book, it is to be understood that a knowledge of the calculus and, to a certain extent of analytical mechanics is required for its perusal. The headings of the eight chapters will give a better idea of the scope of the book: Resistance and elasticity of materials; pipes, cylinders and rivetted joints; cantilevers and simple beams; restrained and continuous beams; compression of columns; torsion and shafts for transmitting power, combined stresses; and appendix.

We would have preferred to see the terms *stress* limited to the internal forces or reactions between the particles of a body, and to find *factor of safety* replaced by the working stress or maximum allowable stress, in conformity with the best present practice. The discussion in Chapter VIII. in a measure remedies this latter objection. His introduction of practical exercises and problems oblige the student to familiarize himself with the principles of the text.

While the limited number of pages restricts the ground that can be covered, the principles which are laid down, are very clearly enunciated.

We regret however, that no treatment of thick cylinders is given and that a more exhaustive discussion of riveted joints is not introduced. It would have been well also to intimate that the usual formula for torsional moment of resistance does not give a strictly correct value when applied to square shafts.

Competitive Examinations.

I have before me the second annual report of the Civil Service Commission. From this I extract at random a few of the conundrums asked by the Examining Board.

"From 1,000 grams of pure gold may be coined 279 of the ten-mark pieces of Germany. One gram is equivalent to 15.432349 troy grains. The United States gold dollar contains 23.22 troy grains. What is the equivalent in United States dollars of the ten-mark piece decimally expressed?

"Give the operation in full.

"Name the bones of the Tarsus.

"What are the secretions that act on the food in the process of digestion?

"What are some of the diseases supposed to be due to filth?

"Name the two most common forms of malaria fevers and the more common sequelæ of these diseases.

"The silver coinage of France in 1882 amounted to 1,159,859.50 francs. The value of the franc is 19.3 cents. What was the value of this coinage expressed in the money of the United States?

"Give the operation in full?

"If four horses draw a railroad car 8½ miles in an hour, how many miles an hour can a steam engine of 106 available horse power drive a train of thirteen cars, the locomotive and tender being counted as three cars?

"Give operation in full.

"What is the specific gravity of a composition of forty pounds of copper, specific gravity 8.95; twenty pounds of zinc, specific gravity 7.15, and one pound of silver, specific gravity 10.50?

"Give operation in full.

"What per cent. of alcohol is there in a mixture of nine gallons 86.100 strong, twelve gallons 92.100 strong, ten gallons 95.100 strong, and eleven gallons 98.100 strong?

"Give operation in full."

This latter question anybody could answer with a jug, but applicants are not furnished with them.

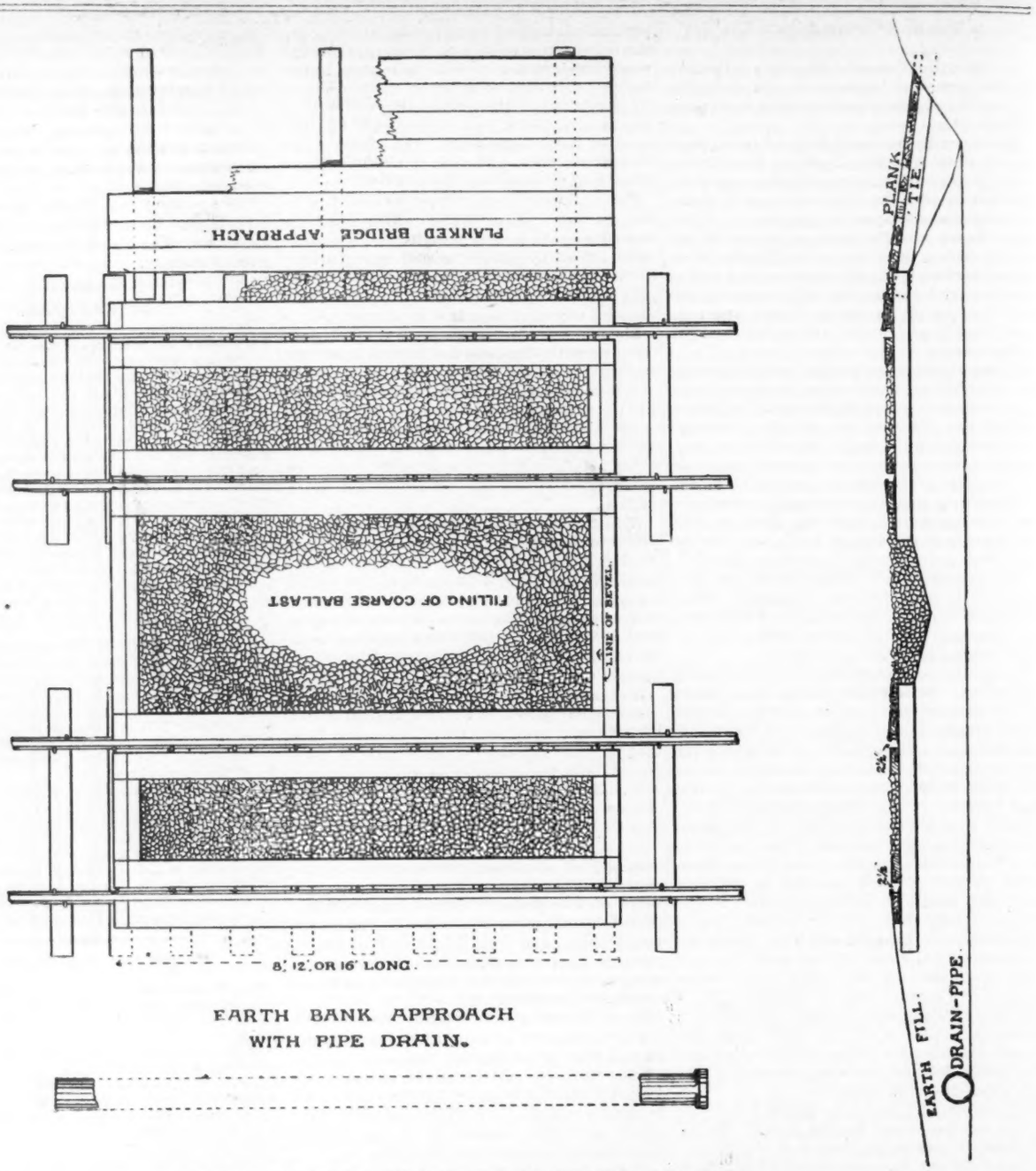
"Describe the steam engine, stating anything you know regarding the mechanical force excited in water by the combustion of a given quantity of coal. When is steam said to be used expansively?

"Distinguish between reflection and refraction of light, and give example.

"Describe electricity, its kinds and its best known applications.

"What is the relation of volume of gases to pressure? State what you know of the diffusion of gases."

These questions serve to show how small a chance one has of entering the public service through the doors of the humbug Civil Service Commission.—*From the Cincinnatti Enquirer.*



EARTH BANK APPROACH
WITH PIPE DRAIN.

FIG. 99.—ROAD CROSSING—BALLAST FILLING BETWEEN GUARDPLANKS.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 12*).

This arrangement is shown in Fig. 99, with two styles of approach over the ditch, on a bridge of ties and plank, the other a fill with pipe drain. The length of the crossing should be regulated according to the travel over it. Thus it is sufficient to make an ordinary farm crossing 8 feet long unimportant highways 12 feet, principal throughfares and streets according to local requirements. The best material to use for planking is Georgia yellow pine, which is very durable, lies flat and does not twist or curl, the last named qualities being the objections to oak. In winter the planks at farm crossings and wherever else possible should be taken up to avoid the liability of their being raised by post and striking engine pilotsor snow plouges.

On all roads there are needed a number of signs or warning signals, and as they are repeatedly used, it is well to have adopted signs by which to make them. Some of these signs are required by law, while others are used as part of the system of operation. In designing them it should be remembered that they are intended for practical purposes, and therefore any attempt at elaborate ornamentation either by moulding or color is artistically false and out of place, besides reducing the signal's effectiveness and adding to its expense. The various signs should be made durable, of proper size, and in shape simple; the lettering should be large, clear and bold, and the colors black and white, unless some special point is to be gained by the change. In addition to the actual size of each of the signs, its height above base of rail and the distance it is to be set out from the rail must be determined for the sake of uniformity. The former of these alters length of post requires according as the sign is to be set up in a cut or on a bank.

Unless specially noticed to the contrary it is recommended to set the signs 7 feet from the rail on banks and 8 feet in cuts, although these figures may frequently have to be modified by the configuration of the ground. These distances conform with roadbed cross-section of P. R. R. & A. Y. L E. & W. R. R. previously illustrated.

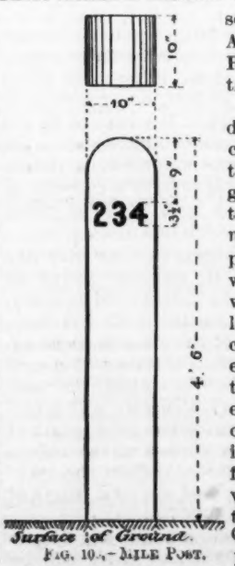


FIG. 100.—MILE POST.

The signs can be divided in three classes according as they are intended to govern the Transportation or Maintenance of Way departments, or are to warn outsiders, of which classes the following are the principal and most used examples. Although there are many others required for special and other causes, it is hoped that the following selection will at least illustrate the subject. Class 1. Fig. 100 represents a Mile Post.

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The post should be stout and substantial, 10″×10″ in cross-section, and not less than 7 ft. 6 in. long, so as to permit its being set 3 feet in the ground and be 4 feet 6 in. above its surface. It should be painted white with distinct black figures. The figures can be painted or else made of cast-iron and attached with screws according to the practice of Penn. R. R. For simplicity the top can be rounded over and covered with tin to protect the post from the weather. Since the mile post is used as a land mark and not as a warning signal, it should be set not less than 10 feet from the rail. In England the law requires half mile and quarter mile posts as well as mile posts, but in this country railroads are content with the latter subdivision.

"Whistle and Ring" posts. On approaching crossings State laws require the engine's bell

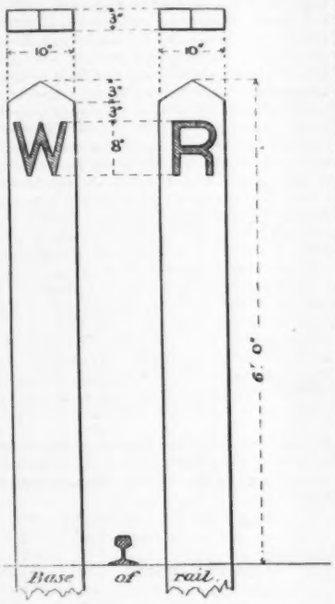

FIG. 101. "WHISTLE AND RING" SIGN.

or whistle to be sounded according to local necessity. Since the law prescribes a point (generally about ¼ mile from crossing) where to commence ringing or whistling, it is essential to mark this spot with a signal. Fig. 101 shows an appropriate design. The posts can be made alike, simply painting on the proper letter. In order to prevent their being mistaken for mile posts and to make them show clearly when ground is covered with snow, the face of the post should be painted cobalt blue, with the letter white. The sides and back of the post are to be painted white.

(TO BE CONTINUED.

The St. Gothard Tunnel Contract.

The great work of constructing the St. Gothard Tunnel has been attended with the disagreeable episode which closes so many contracts, and a protracted lawsuit has only recently been settled. From the very commencement of this work personal jealousies began to assert themselves, mistakes were made in the surveys, while some of the engineers favored a contractor who was not of M. Favre's nationality, and who did not get the work. Obstacles were placed in M. Favre's way from the outset, and after he had almost perforce got possession of the land for commencement of the work, the natural difficulties which presented themselves were aggravated by the action of those who should have afforded every assistance instead of hindrance, some even of these being members or directors of the St. Gothard Company. The result of all the obstacles thrown in his way, and of the structural difficulties which resulted from meeting with a length of about 3,000 yards of soft material which, under the pressure of the superincumbent mountain rocks, crushed not only staging and struts but even heavy masonry, was that the completion of the tunnel was delayed by over a year.

The section of the company which had all along acted with animus against M. Favre, several times threatened and did commence action against him for non-completion of the tunnel. The behavior of this part of the company became so obviously unfair that it gained thereby a most unenviable notoriety in Switzerland, and the whole Swiss press took up the great contractor's side. The company even went to the length of confiscating some of the securities lodged with them as caution. All this took place while the completion of the tunnel could have been no use whatever to the company, for the lines leading to and from the tunnel were not completed until a long time after the tunnel was finished, so that when it was done the company was not ready to use it, this being chiefly due to the mistakes which had been made by the engineers of the railway—mistakes which cost over a hundred thousand pounds. The Swiss press unanimously denounced the behavior of the company, and called for the intervention of the Federal Council, who were empowered to settle disputes, and to prevent the consummation of an injustice which would have been a dishonor to the country. After the work was completed some attempts were made to settle the matters in dispute by arbitration: but these were unsuccessful, and appeal to law was forced upon the contractor, M. Favre, or rather upon his executors, for M. Favre had lost his whole fortune in the undertaking, and had died before it was completed. The company entered an action in the Swiss courts, in which it demanded: (1) That the contractors should be required to pay or credit the company with a sum of 5,584,080 fr., with interest from October 15th, 1881, for advances for installation purposes, etc. (2) That the contractors be condemned to pay 2,745,000 fr. as fines, according to the contract, on account of failure to complete various portions of the tunnel within the prescribed time, interest to be 5 per cent.

(3) That they repaid 500,000fr., which they had in instalments as loans; interest was reckoned at 5 per cent. from the dates of the various instalments. This makes the total sum demanded by the company 8,829,080 fr., in addition to interest, which would bring the amount up nearly 10,000,000 fr. The contractors, however on their part demanded no less than 14,700,000 fr. from the company. Of this sum, 2,184,000 fr. was set down for extra work in the tunnel unprovided for in the contract; 600,000fr. for installation works, and 438,000 fr. under various minor heads, while no less than 11,500,000fr. were demanded on the ground of delay in furnishing the contractors with certain necessary instructions as to the details of the construction, and further, on account of the hostile animus of the chief engineer, Herr Hellwag, and his assistants. The loss on those two heads was reckoned by the contractor at 10 per cent. of the entire cost. They further reckoned 2 per cent. for loss during the financial crisis of the company, and 8 per cent. for unforseen difficulties, as extra pressure, excessive heat, etc., which they had encountered in constructing the tunnel. Much interest was felt in engineering circles on the Continent as to the issue of the lawsuit. Curiosity was particularly excited as to how the Swiss courts would deal with some of the contractors' demands for compensation, especially those under the heads of the hostile *animus* of the engineers and the unforseen difficulties in the construction of the tunnel. The sums mentioned were subsequently a little altered, but were substantially the same in amount.

It is unnecessary that we should follow the case in the Berne courts; it is sufficient, perhaps, to give the results of the recent judgment. The court rejected the demand of the company for the 2,745,000 fr. made on the ground of non-completion to date. It condemned the company to pay to the representatives of M. Favre 1,000,000 fr. in respect of the great difficulties in the 3,000 yards length above referred to, and a further sum of 750,000 fr. as general indemnity to cover the losses due to the animus of the chief engineer, Herr Hellwag, and some of the assistant engineers. All the other demands of the company were rejected, but it should be stated that, in the meantime, the Favre people had obtained 13,963,560 fr. and interest, less the 5,584,000 fr. which had been advanced for installation.

The St. Gothard Company had for some time reserved four million of francs, so as to be prepared for what must have been seen to be the inevitable result of the litigation. Only half this sum has, however, been awarded to the contractors, so that even now the company has succeeded in getting its tunnel for about 2,000,000 fr. less than was thought to be the probable price, and has that sum to the good.

It is perhaps impossible to provide against the litigation end of great undertakings when personal interests and jealousies enter into the work from the first. The international mixture of engineers and contractors in this case was the chief cause of the trouble, but it must be hoped that the time will come when a spirit of fairness will reign in sufficient strength to prevent those for whom work is done from trying to get it done at the cost of ruining the man who has done it. M. Louis Favre met and overcame the most unparalleled difficulties in the construction of the St. Gothard Tunnel, and it is to be regretted that he should have been so disgracefully treated, and it cannot be admitted that the 1,750,000 fr. is a sufficient award to his executors.—*The Contractor.*

A STRIKE appears imminent at Beloit, Wis. The diggers employed by the water-works contractor demand $1.50 per day, but the contractor will pay only $1.30

The Recording of Town Plats in Michigan.

Sections 1473 and 1474, Chapter 32, Howell's Annotated Statutes as Amended by an Act of the Michigan Legislature Approved May 21, 1885.

(§ 1473) SEC. 1. Whenever any town, city, village, or addition thereto, shall be laid out, or shall be altered or vacated as hereinafter provided, within this State, the proprietor or proprietors thereof shall cause a true map or plat thereof to be made by a civil engineer, surveyor, or other competent person. Such map or plat shall in every case be made on a scale showing not more than two hundred feet to an inch, on sheets of good muslin-backed paper, eighteen inches by twenty-four inches in size. There shall be written upon the paper on which said map or plat shall be made a full and detailed description of the land embraced in said map or plat, showing the township and range in which such land is situated, and the sections and parts of sections platted, and containing the name of the town, city, village, or addition platted, the name or names of the proprietor or proprietors thereof, and of the engineer, surveyor, or person making said map or plat, with the date. The same shall be signed by such proprietor or proprietors, and engineer, surveyor, or person making the same, and shall be witnessed and acknowledged as deeds conveying land are required to be witnessed and acknowledged. The sections and parts of sections platted shall also be designated by lines drawn upon said map or plat, with appropriate letters and figures (and in case of a subdivision of lots or blocks of a previous survey, the outlines of the original or previous lots or blocks so subdivided shall be designated by lines drawn upon said map or plat, and shall be marked with appropriate letters and figures.) There shall also be on such map or plat a plain designation of the cardinal points, and a correct scale. Such map or plat shall be recorded in the office of the register of deeds for the county in which the land platted is situated. Before such plat shall be recorded, and before any copies are made therefrom, the person making the same shall forward the original plat to the Auditor General of the State, who shall approve of the same whenever such plat shall conform, in his opinion, to the requirements of this act, and shall return the plat to the person who forwarded it, with his approval endorsed thereon. For the purpose of such recording the said proprietor or proprietors shall cause to be made by a civil engineer, surveyor, or other competent person, on the same scale, and on paper of the same size and quality, as that on which the map or plat is required to be made, an exact duplicate of said map or plat, with the detailed description, and signed, witnessed, and acknowledged, as above specified. When such map or plat shall conform, or shall be made to conform, in all respects to the requirements of this act, the said register and said engineer, surveyor, or person who made the same, shall separately carefully compare said duplicate with said map or plat, and if correct, or when made correct, it shall be certified by the said register and said engineer, surveyor, or person who made the same, who shall certify that they have carefully compared the same with said map or plat (describing it), and that it is an exact duplicate thereof and of the whole of such map or plat. The said register shall then securely fasten the said duplicate in a book of the proper size for such paper, so that it shall not be folded, which book shall be strongly bound in leather, and provided at the expense of the said county, and such duplicate so fastened in said book, shall be held and taken to be a record of the said map or plat, with like effect as if the said map or plat had been actually transcribed by said register in a book in his office; but in no case shall any such map or plat be recorded until it shall be made to conform to all the requirements of this act, nor until such duplicate shall be made an exact duplicate of said original map or plat as approved by the Auditor General, and for any willful violation of this provision by a register of deeds, he shall be liable to a penalty of ten dollars, and shall also be liable to pay all damages which any person may sustain by reason thereof, to be recovered in an action of trespass on the case. The register shall certify on such map or plat the time when it was recorded as aforesaid, with a reference to the book or page where recorded. He shall note on the record the time when made, and shall keep a separate index of maps or plats, in which he shall enter, alphabetically, the name of every town, city, village, or addition, the map or plat of which shall be recorded by him, with a reference to the book and page where the same shall be recorded. There shall be made a true copy of the said duplicate of such map or plat so recorded, on paper of the same quality and size as above prescribed and on the same scale, which copy shall be certified by the said register and engineer, surveyor, or person making the same, who shall certify that they have, separately, carefully compared the same with the duplicate so recorded, and that it is a true transcript therefrom and of the whole of such duplicate so recorded. Such copy so certified shall then be delivered to the Auditor General of this State, who shall file the same in his office. The Auditor General shall keep an index in which he shall enter alphabetically, the name of every town, city, village, and addition, a copy of the recorded duplicate of the map or

plat of which shall be filed in his office, the date of filing the same, and whatever else he may think necessary to facilitate reference thereto. On delivering such copy to the Auditor General, the person delivering it shall pay into the State treasury, to the credit of the general fund, the sum of one dollar. The original map or plat, with the certificate of record endorsed thereon, the recorded duplicate thereof made as aforesaid, or a properly certified transcript of such recorded duplicate shall be received in all courts of this State as *prima facie* evidence of the making and recording of such map or plat in conformity with the provisions of this act, and the copy of such recorded duplicate filed in the Auditor General's office, or a properly certified transcript thereof, shall be received in all courts of this State as *prima facie* evidence of the above matters, and also the filing of said copy in the Auditor General's office. If any person or persons shall sell any lot or lots within any such town, city, village, or addition, before the map or plat thereof shall be recorded and the copy of the record thereof filed as aforesaid, he or they shall forfeit and pay the sum of ten dollars for each lot so sold. For all services by this act required to be performed by a register of deeds in respect to any such map or plat brought into his office for record, the said register shall be entitled to receive the sum of two dollars, which shall be paid by the proprietor of the ground platted: *Provided*, That in all cases where the proprietor or proprietors of any piece or pieces of land shall have caused the same to be laid out and platted as a city, town, or village, or as an addition to a city, town, or village, or where the proprietors have caused such city, town, or village lots to be deeded by metes and bounds, and courses, and have failed or neglected to have a plat thereof made and recorded in the office of the register of deeds of the county in which such land is situated, the supervisor of the township in which such land is situated shall, when authorized by the the township board of such township, cause a map or plat of said city, town, village, or addition to be made under his hand and seal, properly acknowledged by him and showing by reference to this act the authority for the same, and have the same properly recorded in the office of the said register of deeds, and filed in the Auditor General's office, as hereinbefore provided, and such plat or map when so recorded and filed, shall be treated in respect to the assessment, collection, and return of taxes, and the sale of said lands for delinquent taxes, as if the same had been made by the proprietor or proprietors: *Provided*, That such proceedings shall not interfere with vested rights: *Provided further*, That the expense of making said plat or map, when done by the supervisor, according to the provisions of this act, shall be paid by the township in which such city, town, village, or addition is located.

(§ 1474) SEC. 2. That such maps or plats as are by this act required to be recorded, shall particularly set forth and describe such portion of the government survey as is intended to be platted, and when said premises are not included in the legal subdivisions of the government surveys, then the boundaries to be defined by metes and bounds and courses. Said maps or plats shall also particularly set forth and describe all the public grounds (except for streets and alleys by their boundaries, courses, and extent, and all streets and alleys by their courses, lengths, widths, names, or numbers, by writing or figures upon that portion of the map or plat, intended for those uses. And all the lots intended for sale may be numbered, either by progressive numbers or if in blocks, progressively numbered in each block, and the blocks progressively numbered or lettered. Where all the lots in any block are of the same dimensions it shall be sufficient to mark the precise length and width upon one tier thereof, but all gores, triangles, or other lots, which are not either squares or parallelograms, shall have the length of their sides plainly defined by figures. And the maps so made and acknowledged by the civil engineer and surveyor making the same and acknowledged by the proprietors thereof; or by the supervisor as authorized in the preceding section before a justice of the peace or a notary public of the proper county, where the town, city, village, or addition lie, or before any judge of any court of record, and certified under the hand and seal of the judge, justice, or notary public taking such acknowledgment, and recorded, shall be deemed a sufficient conveyance to vest the fee of such parcels of land as are therein expressed, named, or intended for public uses in the county in which the said town, city, village, or additions lie, in trust to and for the uses and purposes therein named, expressed or intended, and for no other use or purpose whatever.

IRON PAINT.—A recent German invention, composed of pulverized iron and linseed varnish, is intended for covering damp walls, outer walls, and, in short, any place or vessel exposed to the action of the open air and to the weather. Should the article to be painted be exposed to frequent changes of temperature, linseed oil varnish and amber varnish are mixed with the paint intended for the first two coats, without the addition of any artificial drying medium. The first coat is applied rather thin, the second a little thicker, and the last in rather a fluid state. The paint is equally adapted as weather-proof coating for wood, stone and iron, nor is it necessary to previously free the latter from rust, grease, etc., a superficial cleaning being sufficient. This paint will prove a valuable auxiliary to manufacturers.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

(CONTINUED FROM PAGE 413)

DCCLXII, RED OAK, IA.

Red Oak, Iowa in lat. 41° N., long. 95° 20′ W, the county seat of Montgomery Co., is in undulating fertile prairie land. Settled in 1864, it was incorporated a village in 1868.

Water-works were built by the village in 1880-81 after plans of P. B. Perkins taking the supply from Nishuabatua creek for fire purposes and from two large wells for domestic use. The water is pumped by two Smith and Vaile pumps, each of 16-inch steam and 8-inch water cylinders and 18-inch stroke directly into the mains, furnishing an ordinary pressure of 70 and a fire pressure of 110 pounds.

Distribution is by 6 miles of wrought-iron pipe of 10 to 6 inch diameter with 40 fire hydrants, 18 gates and 450 taps. service pipes are of lead and wrought-iron. The cost of the works has been $32,400. The population in 1880 was 3,755 and is now said to be 4,500. The names of the officers of the works are not given.

DCCLXIII. REINBECK, IA.

Reinbeck, Grundy, Co., Iowa, is in lat. 42° 30′ N., long. 92° 45′ W.

Water-works were built in 1883, by the town taking the supply from ground water. From a well 6 feet in diameter and 20 feet deep, in the bottom of which a 3 inch iron pipe is sunk 43 feet, the water is pumped by wind power to a wooden tank, 20 feet in diameter and 16 feet high, set on a trestle 20 feet in height, the bottom of the tank being about 80 feet above the hydrants.

Distribution is by half a mile of 8 inch Wyckoff wood pipe, with 4 fire hydrants and two taps.

The works have cost $4,000, and are chiefly for fire protection. The town pays $26 yearly for hydrants.

The bonded debt is $2,150 at 8 per cent. The population in 1880 was 482. J. B. Tallmadge manages the works.

WATER.

Tampa, Florida, will put up water- works on the Holly system.

Mason City, Iowa, has issued $28,000 water-works bonds, W. D. Preston, of Chicago, being the purchaser at a premium of $880.

THE Pond Engineering Company, of St. Louis, have been awarded the contract to erect the steam plant complete for the Belleville, Ill., water-works.

THE contract for the Newark, O., water-works has been awarded to Messrs. Hinds Moffet & Co. of Watertown, New York, for $12,000.

CITY Engineer Jackson, of Boston, Mass., has addressed a communication to Mayor O'Brien, suggesting a commission of disinterested civil engineers to study the problem of the extension of the high service water supply of that city.

THE New York Central engines are to take water while in motion the same as those of the Pennsylvania road. Cast-iron troughs, 6 inches deep and 8 inches wide and 1200 feet in length, are to be laid between the rails. A scoop drops into the trough, filled with water and the velocity of the train forces the water up into the tank.

NEW ORLEANS, July 4th.—The artesian well craze has struck this city and several factories are at work boring for water. The city waterworks are able to supply all demands, but the water from the Mississippi River, from which the supply is drawn, is very muddy, and has to be filtered or clarified to make it fit to be drunk or to be used in the factories. The well-borers hope to find clear water below the level of the bed of the river.

AT a meeting of the Toronto (Canada) water-works committee, June 30th, Superintendent Hamilton reported that when the engines are stopped the pressure is deficient and that it will be necessary in the near future to establish a second reservoir. The Chairman thought the citizens would be averse to going into the expense of a second reservoir at present. He suggested that the superintendent be asked to report the expense of a second 24-inch main from the reservoir to College treet. The Chairman's suggestion was adopted.

FORT GRATIOT, MICH.—This town is willing to spend $25,000 on water-works.

EAU CLAIRE, WIS., June 29th.—Hinds, Moffet & Co., of Watertown, N. Y., have been granted a franchise to build and operate waterworks at Menominee. The firm is to lay five miles of pipe, with not less than eight hydrants. The source of supply is to be the pond near the Knapp, Stout & Company's bridge. The reservoir will be located on the hill near the court house elevated enough to throw water 100 feet high from hydrants near the court house by means of the reservoir pressure alone. The city pays $4,000 per year for the eighty hydrants, and the rates for private consumption are not to exceed those charged at Eau Claire. The city may purchase on appraisal after ten years, or at any interval of five years after the first ten years. The works are to be completed December 1st next, and will cost $60,000.

AN INCH OF WATER.—A statute or legal inch of water in California is the water discharged through an opening 1 inch square under a pressure of 4 inches from the center of the orifice to the top of the box or point of overflow. This is equivalent to .02 cubic foot discharge per second, 1.2 cubic feet per minute, and 72 cubic feet per hour. To reduce to gallons multiply by 7.48, which gives about 9 gallons per minute. The "miner's inch" runs from 5 to seven inches pressure, varying with locality. The great hydraulic companies, however, have agreed upon a six-inch pressure, which gives by actual measurement, as made by Hamilton Smith at the North Bloomfield, 2,260.6 cubic feet per 24 hours, or 94.2 cubic feet per hour. In reducing to inches the water stored in reservoirs the practice is to allow 100 cubic feet per hour. For irrigating heads the pressure runs all the way from 3 to 8 inches among commercial ditches. The latter is—or was recently—in use by the National Canal Company, Sacramento County. That company measures through an orifice 4 inches deep, with 6 inches additional to overflow. In regard to the measuring box, the practice is quite uniform. It should be so large that the inflow will not create a perceptible current or commotion. The opening is usually 2 inches in depth, its length being regulated by a tight-fitting slide, each half-inch being equivalent to an inch of water. The edges are smooth, and, if necessary, are chamfered on the outside.—*San Bernardino (Cal.) Times*

HEALTH Commissioner Steuart, of Baltimore, has had the water in Lake Montebello, Lake Roland and Druid Lake analyzed by Prof. Tonry, who reports the following analysis:

FOREIGN MATTERS.	Lake Montebello.	Lake Roland.	Druid Lake.
Free ammonia, milligrammes per litre	.08	.05	.04
Albuminoid ammonia " "	.14	.10	.10
Chlorine, grains per gallon	.45	.40	.30
Valatile solids, grains per gallon	4.50	4.00	3.50
Minerals " " "	5.80	9.30	5.50
Total " " "	10.30	13.30	9.00

The samples are all marked as suspicious. The water from Lake Roland flows into Druid Lake, and from the analysis it would be judged that the water purifies itself during its flow, as the analysis shows that the water in Druid Lake contains a smaller amount of impurities than the water of Lake Roland.

NEWS OF THE WEEK.

Contracting.

The Schenectady Locomotive-works, Schenectady, are building at the rate of ten locomotives per month.

The Wagner Sleeping Car Company is having eight new sleeping coaches built at the works of Barney Smith & Co., Dayton, Ohio.

Minneapolis Bridge.—Several of the piers for the new St. Paul & Northern Pacific bridge in South Minneapolis, are nearing completion, and the excavators are at work on the river bank below the state university, making room for the main pier on the East side.

Several Bridges have been contracted for by the King Iron Bridge Manufacturing Co,. of Cleveland, Ohio, during the past week, among which are two bridges across Des Moines River at Des Moines, Ia. for $50,000. Two bridges near Rochelle, Ill., for $7,500, and a draw-bridge across Cuyahoga River at Cleveland, Ohio, 200 feet span, for $16,000.

Contracts in New York City.—The following are contracts to be let in this city:—

Repaving 5th Avenue from 9th to 90th St. with granite blocks. To be let July 20th. For paving with granite, 3th St. from Bowery to Lewis; 9th St. from Avenue A to First Avenue; 47th St. from 10th to 11th Avenue; and trap-block pavements and seven other streets, all to be let July 16th. For laying water-mains, to be let July 14th. For further particulars apply to Rollin M. Squire, Commissioner of Public Works, No. 31 Chamber Street.

A New Hotel, to cost $50,000, is to be erected this season at Southern Pines, N. C., by a company formed for the purpose. John T. Patrick, of Raleigh, can furnish information.

Suspension of Work at Vera Cruz Harbor.—CITY OF MEXICO, via Galveston, June 29.—Included among the companies whose subsidies were stopped is the Vera Cruz Harbor Improvement Company, a French concern. It is announced to-day that this company will have to suspend operations, leaving the most important part of the work incomplete.

Penitentiary at Allegheny, Pa.—Sealed proposals will be received by the Board of Inspectors of the Western Penitentiary of Pennsylvania until 7 o'clock P. M. of Tuesday, July 14, 1885, for the necessary excavation, piles and pile driving, concrete and stonework in the foundations of the new South wing of said penitentiary. Separate bids will be received for each branch of the work. Plans and specifications can be examined at the office of E. M. Butz, Architect, No. 314 Federal street, Allegheny.

The Penn. Frog and Switch Company, a new organization of Philadelphia and Chester capitalists, has purchased a half square of ground on the Philadelphia, Wilmington and Baltimore Railroad, in the South Ward, Chester, and will shortly begin the erection of large buildings for their works. They intend to manufacture a new style of railroad switch under patents granted to Mr. Johnson, now superintendent of Wharton's Switch Works, Philadelphia. They claim that theirs is a great improvement over the Wharton switch. They also control other valuable patents on railroad machinery. A large number of men will be employed.

The United States Tubular Rolling Stock Company, of New York, publishes a letter from General Manager C. W. Smith, of the Chesapeake and Ohio Railroad, regarding one of its cars, a gondola, thirty-four feet long, weighing 18,900 pounds, in which he says: While the car has carried many light loads, it shows a record of heavy weights during the month of May as follows: On the 5th it carried a load of 61,000 pounds; on the 9th, 59,600 pounds; on the 12th, 69,100 pounds, and I regret to say that on the 15th it is found to have carried a load of 80,800 pounds—an average load of 33¾ tons, the loading being iron ore.

The Edgar Thomson Steel Works, have received an order from the Chicago, Burlington & Quincy railroad for 10,000 tons af steel rails. The order was given last Thursday by Henry B. Stone, the assistant general manager of the road. He stated that this order would be followed by another of 20,000 tons very shortly. He says that no steel rails in the country surpass those made at this mill. The Union Pacific railroad has placed a large order with the Edgar Thomson. The works are now running on double turn and turning out each day about five hundred tons of rails. It will therefore, take not more than twenty days to run out the order of the Chicago, Burlington & Quincy railroad. They claim to have orders ahead now enough to keep them running on double turn until December.

St. Paul, Minn., Public Work.—City Engineer Rundlett has prepared a number of estimates of the amount of public work to be done in St. Paul in certain departments this year. These estimates are:

Length of wooden walks to be laid, 27 miles; cost of same, $42,000; area of stone sidewalks to be laid, 26,000 square feet; cost, $10,400, length of cedar block paving, 3,000 lineal feet, and 1,500 feet of Kerr pavement, the first costing $25,000, and the Kerr $14,504. The sewer contracts are:

Contracts.	Length in feet.	Price.
Broadway	620	$6,200.00
Western avenue system	9,230	20,000.00
Goodrich avenue system	11,980	35,723.00
Summit avenue system	2,670	6,496.00
Iglehart and Josette system	1,500	3,270.50
Iglehart system	610	1,196.00
Franklin system	758	2,393.00
Jackson system	350	997.00
Washington system	640	1,273.00
Jackson, Third to river	420	989.00
Bradley	1,950	6,819.00
Ninth	340	555.00
Tenth	370	630.00
Marshall	570	774.00
Oakland	2,476	2 449.00
Total	34,434	$89,854.50

Length now under contract, six and one-half miles; probable additional length, one and one-half miles; total length, eight miles; cost, $112,000.

Railroads, Bridges and Canals.

A New Suspension Bridge, 968 feet long, is to be built over the Lehigh River at Easton at a cost of $23,000.

The B. & O. in Philadelphia.—PHILADELPHIA, July 3.—The Mayor this afternoon signed both of the Baltimore and Ohio Railroad ordinances giving that company a right of way through the city.

The Milwaukee Lake Shore & Western Railway.—announces the completion of its line to Ashland, Wis., on Lake Superior. At Ashland connection will be made with the recently completed line of the Northern Pacific Railroad and with steamers for all Lake Superior ports.

Mileage in Ohio—Of single track there are 6,331.568 miles of main line, 369.19 miles of branches, making the total single track of 6,900,756 miles. Of double track there are 278.527 miles; of sidings, 1,657.048 miles; total rail, 8,836,331 miles.

Suburban Railway Construction.—KANSAS CITY, MISSOURI, July 1.—Work was commenced to-day on the elevated railway which is to be built between this city and Wyandotte, Kansas. The line will be about two miles in length and will connect with the new cable street railway. It is proposed to complete the elevated line within two years.

St. Louis & Kansas City Short Line.—Directors of the newly projected St. Louis & Kansas City Short line met June 30 and organized by electing the following officers: President, R. P. Williams; vice-president, Gen. Odin Guitar: secretary, J. H. Cardell; treasurer, J. H. Waugh. Engineers will be put in the field in a few days.

A New Canal has been started at Catlin, Col., by an incorporated company. It is to be forty miles, and, when completed, will be capable of flooding 150,000 acres. Thus far it has been surveyed but twenty-four miles. The grading is already completed for a distance of three miles, and is being pushed along as rapidly as possible.

Work on the Vicksburg Inclines Progressing.—VICKSBURG, MISS., July 3rd.—The work on the inclines of the Queen and Crescent Railroad for crossing the Mississippi River at South Vicksburg is progressing rapidly. The grading of about ten thousand cubic yards on the Louisiana side has been completed, and pile driving has commenced on this side. Messrs. Gorman & Lewis, contractors, have thirty-five wheel-scrapers and sixteen carts with a large force of men at work, and expect to complete the excavating—about thirty thousand cubic yards—by the 25th of the present month. Owing to the high stage of the river, the work of driving piling will be delayed some two weeks.

New Road from Philadelphia to West Chester. Pa.—PHILADELPHIA, July 6th.—The charter and partly graded railroad line of the old Philadelphia and Chester County Railroad Company, specially chartered by the Legislature before the adoption of the new Constitution, have been purchased, and a new corporation is being organized to complete the middle line from Philadelphia to West Chester. This line is some five miles shorter than either the Media or the Thayer lines to West Chester, and will open up a rich and productive portion of Chester County. It is expected that the new line will be completed about Jan. 1st, and that arrangements will be made with either the Pennsylvania or the Baltimore and Ohio for terminal facilities in Philadelphia.

The Pinkerton Tunnel, on the Pittsburg division of the Baltimore & Ohio road, was opened for traffic, July 2nd. The tunnel was originally completed in 1871. It was then lined with wood. In 1879, this wooden lining caught fire, and communicated to a coal strata in the roof. All efforts to quench the flames proved unavailing, and a track was hastily surveyed and constructed around the hill, a distance of about two miles. Though the fire gradually died out, the roof of the tunnel fell in, and it passed into a state of ruinous decay. The new tunnel cost, in round figures, $120,000. It is 1,034 feet in length, and is arched from portal to portal with brick, supported by massive walls of masonry. There are 1,800,000 bricks and 2,275 yards of masonry in the tunnel. It is 28 feet wide in the clear, and 27 feet high, amply big enough for two tracks.

An Underground Railroad for Chicago.—Alderman Young introduced an ordinance into the Chicago Council, June 29, granting authority to the Chicago Rapid Transit Company to occupy all

"Streets, highway, avenues, alleyways, public places, public property, water courses and ways" for the purpose of constructing, maintaining, and operating underground railways, "commencing at an imaginary point on North Clark street, where Fullerton avenue intersects the center line of said Clark street; thence running in a southly direction under and along said Clark street to the intersection of Clark street and La Salle avenue; thence under and along La Salle avenue southward to and under the Chicago River; thence under and along La Salle southward to the intersection of Jackson street; thence on a proper curve eastwardly under and along Jackson street to the intersection of Dearborn and Jackson streets; thence south under and along Dearborn to center of Thirty-ninth street. Also from a point of connection with said Road at Jackson and La Salle to and under South branch Chicago River; thence, under, etc., Jackson street to Barry Point road; thence under Barry Point road to city limits." Cable, steam, or other power can be used. No permanent injury is to be done to streets, sidewalks, gas, water-pipes, etc., and no street is to be opened or encumbered more than necessary to enable the company to proceed to advantage. The company is to be taxed only for its actual assessed value, the same as other business property; work to be begun within a year, the rights and privileges to remain in force for ninety-nine years.

Underground Railways in Paris. PARIS, July 5.—A Government bill has been presented in the Chambers for the construction of 25 miles of underground railways in Paris at a cost of 210,000,000 francs. One-third of the capital is to be raised by shares without guaranteed interest, and 140,000,000 francs by debentures, the State guaranteeing 5 per cent.

Substituting Steel Rails.—WAUPACA, Wis., Special Telegram, June 30.—The Wisconsin Central has been quietly taking up its main line from Milwaukee to Ashland, and relaying the bed with the best quality of steel rails. The company is now busy preparing a new time table, which will go into effect in a few days, and which shortens the running time between the above places something over an hour. Elegant parlor cars are now run on all day trains.

South Penna. R. R.—PHILADELPHIA, PENN., July 3.—In spite of reported conferences between the Pennsylvania and the New York Central Railroad interests relative to the abandonment by the latter of the South Pennsylvania Railroad, which is the proposed connecting link between the Reading and New Jersey Central and the W. st it is officially stated here to-day that work on the projected line is being pushed forward with all possible speed.

The Mexican National.—LAREDO., TEX., June 29.—Mr. D. C. Dodge, Vice President of the Mexican National Railroad, will arrive in Laredo to-night by special train from Saltillo. He has been in the City of Mexico looking after the company's interests there. It is rumored that construction will begin shortly from Saltillo south, and as the company are now building from San Miguel Allende, in the interior of Mexico, to San Luis Potosi, a speedy completion of the road is hoped for.

A New Line to Saratoga.—AMSTERDAM, N. Y., July 1.—A plan is on foot to build a single-track railroad from this city to Saratoga Springs, thereby making a direct route from the West to that resort and the North. The route in view passes through Amsterdam, Charlton, Galway, and Milton. The projectors of the enterprise are said to be New York and Boston capitalists, and some of the parties interested in the Mount McGregor Road and the Galway oil fields, recently discovered. Surveyors will go over the proposed route in a few weeks.

Fast Time on the B. & O. R. R.—The Baltimore & Ohio Railroad Company has been building some very large locomotives. They were tried on the Luray excursion train on Wednesday, and made the run over the Baltimore & Ohio Railway from Washington Junction to Camden station, eighty-two and a half miles in eighty-seven and a half minutes. The run of forty-two and a half miles from the Junction to Washington was made in forty-five minutes, the fastest yet on the record, and from Washington to Baltimore, forty miles in forty-two and a half minutes, including a stop at the Relay station. Mr. C. K. Lord, general passenger agent, was on the train, and the quick running was under his direction, to prove the capabilities of the big locomotives, which are now in the passenger service.

Extending the Penna. R. R. South.—PITTSBURG, July, 4.—It is officially stated that the Pennsylvania Company has decided to extend its system from Washington to Nashville, Tenn., absorbing the Kentucky Union, a road now under construction. The extension which will really be another trunk line from this city, will have for its general direction the shortest survey between Cincinnati and Southeastern Kentucky, thus giving the new enterprise a line between Nashville and Cincinnati. Nashville and Pittsburg, and Cincinnati and the timber, coal, and iron fields of Southeastern Kentucky. The surveys have been completed and the line located between Washington and Kentucky, and engineers are in the field between West Virginia and Nashville. The entire route of the Kentucky Union has been selected and the right of way secured. The expense of the construction of the road will exceed $15,000,000. It is expected it will be completed by July 1, 1887.

A Guatemalan Enterprise.—Mr. Edward Vernon, the well-known railway statistician and projector of railway enterprises, is just now interested in the construction of a railway from a point on the Caribbean Sea to the City of Guatemala, where it will connect with C. P. Huntington's Central American and Pacific Road. The untimely death of President Barrios has embarrassed the work of construction somewhat, but the delay will be only temporary. The enterprise is backed by English money, and no doubt it will be pushed to completion at an early day. It will be a three-foot gauge road, so as to enable it to interchange traffic without reloading with the Central American and Pacific. The two roads will form a continuous all-rail route across Central America and connect San Jose on the Pacific coast and a good harbor on the coast of the Carribbean Sea, which will afford rapid transit between these points and reduce the mileage of the water route to the Pacific coast and island points more than 1,000 miles.

The Texas, Santa Fe and Northern.—Santa Fe, N. M., July 1.—Santa Fe is jubilant over the new turn in the affairs of the Texas, Santa Fe and Northern Railroad. Numerous vexatious obstructions have hindered work on this road for more than a year, but to-day the Directors have closed up several important contracts. The Colorado Coal and Iron Company have been directed to ship the rails from Peublo, and have them upon the ground at Espanola not later than July 15. The tie gang is now being gathered up at Alamosa, Pueblo and Denver, and the bridge-builders and graders have also been ordered by wire to report at Espanola for duty by the end of this week. The Chief Engineer expects to have his labor organized in time to commence laying track from Espanola toward Santa Fe on Monday next. This will put our city in connection with the Denver and Rio Grande Railroad system, and afford another outlet north and east.

Belgian Railways—The London (England) *Railway Gazette*, speaking of Belgian railways, say, as regards mileage in comparison with area, Belgium to-day enjoys the premier position among the nations of the world. Per 1,000 sq. kilom. (621 miles) there are eighty-five miles of railway, in Belgium, fifty-seven in Great Britain, thirty-nine in Germany, thirty in France and ten in the United States. A recent official report shows that there were 3,038 kilom. belonging to the State, and 1,255 kilom. belonging to the companies on Belgian territory. The State railway which extends to Ostend, the principal seaport, runs from Brussels to the frontier of France at twelve points, to the Prussian frontier at one point, to the Luxembourg frontier at two points, and to the Dutch frontier at two points. The rolling stock is extensive. To work these lines the State has 1,570 locomotives, thirteen stationary engines, 3,006 passenger, 691 baggage, mail and express, and 305 other vehicles for passenger service. There are also 41,384 goods vehicles. On the companies' lines there are 533 locomotives, 818 passenger carriages, 449 other vehicles, and 13,915 vehicles for the goods service.

Montreal & European Short Line.—Montreal, July 7.—Vicomte d'Hauterive, of Paris, has returned from Ottawa, where he has been negotiating with the Government in regard to an annual subsidy for the proposed railroad in Nova Scotia between Oxford and Louisburg, known as the "Montreal and European Short Line," of which Dr. Norvin Green, of New York, is president, and in which Erastus Wiman, of Dun, Wiman & Co., and several members of the Dominion Parliament from Nova Scotia are interested. Vicomte d'Heuterive's assistant, Mr. Hamper, a railway financial agent of Berlin, is now in Paris for the purpose of obtaining a loan from one of the largest banks of Paris. This loan is based on the subsidy to be obtained from the Canadian Government as well as on the bonds of line. It is expected that this loan, amounting to about $22,200,000, will cover all the cost ofconstruction. The road is for the purpose of developing the coal traffic of this part of Nova Scotia. The line has no connection with the Canadian Pacific, and it is expected that as soon as it is completed to Montreal a larger part of the traffic between Europe and America will go by this route. It is rumored to-day that the object of George Stephen's journey to England was to float the $15,000,000 of debentures which the company is to issue under new agreement with the Dominion.

Index to Periodical Literature.

Architecture.—*Mill Architecture.*—A practical paper read by Col. J. Hexamer before the Franklin Institute, Dec. 17, 1884, on the construction of safe and fire-proof mill buildings, describing the construction and fittings as well as heating, lighting, etc. He advocates brick walls, wood columns sheathed with a protecting substance, wood roofs covered outside with metal and inside with concrete, and metal sheathed wooden fire doors. *Journal of the Franklin Institute.* July, 1885, p. p. 1 to 17.

Bridge.—*The Machinery and Methods for Founding the Piers of the New Tay Bridge.*—Describes the methods of sinking the wrought-iron cylinders. Moveable platforms composed of water-tight tanks, supported by legs resting on the river bed, carry the plant and keep the cylinders perpendicular. The sections when bolted together are lined with brickwork and pressed down by cast-iron weights, steel "Milroy" diggers excavating inside at the same time; the debris being raised by a centrifugal pump. The excavated material is dumped around outside of the cylinder, which is filled with concrete (6 gravel to 1 cement) carefully packed. The work is described in detail and is illustrated by a sheet of general and detail drawings. *Engineering*, June 26, 1885, p. p. 689, 690.

Canals.—*Ship Canal between Paris and Boulogne.* This scheme is proposed as an adjunct to the deep water harbor now in course of construction at Boulogne and would enable ships of 600 to 800 tons to reach Paris. It is to be from 60 to 70 metres (197 to 230 feet, wide, 90 metres (262 feet) wide at passing places, and 4 metres (13 feet) deep. The distance would be traversed in 5 days; and docks and other works would be constructed at different towns on the canal. A company is being formed to obtain the charter. Maps are given of the route and terminal points. *Les Annales des Travaux Publics*, June, 1885, pp. 1360 to 1370.

Ship Canal from Amsterdam to the North Sea.—Commenced in 1865, and opened for traffic 1876. Length 61 kilometres (38 miles), width 135 metres (443 feet); depth 7 metres (23 feet). Constructed through sand hills and marshes, which it drains, and a dike 1360 metres (4460 feet) long is built across the Zuyder Zee to keep back its waters from the marshes, and is provided with two locks. The bottom and sides of this dike are of fascines, the space between being filled in with clay and sand. The canal and dyke are described in detail, with several drawings. Abstract of a paper by Mr. H. Hayter in the Minutes of Proc. Inst. Civ. Engs. *Les Annales des Travaux Publics.* June, 1885, pp. 1363 to 1366.

Engine Shed.—A paper by F. W. Webb, of the London & North Western Railway (England) describing the type adopted on his line. There are two sheds each for 60 engines and tenders, with repairing shops between. Saw-tooth roofs 15 feet span, with columns 25 feet 6 inches apart. Illustrated. *Min. Proc. Inst. Civ. Engs.* Vol. lxxx. Session 1884-85. Part 2.

Hydraulics.—A description of the plant and modes of operation in use at a large French glassworks where all the handling of fuel, raw material, and finished goods, as well as the workshop operations, is performed by hydraulic power. Illustrated. *Le Génie Civil.* June 13, 1885, pp. 102 to 105.

Lubricants.—*The Theory of the Finances of Lubrication.* A paper read before the Am. Soc. Mech. Engs. May 25, 1885, by R. H. Thurston. It points out that sufficient attention is not given by consumers to the valuation of lubricants and enters into consideration of friction, cost, value, etc. Several formulæ are given. *Journal of the Franklin Institute.* July, 1885, pp. 34 to 45.

Motive Power.—*See* Rarified Air.

Rails.—*The Best Material for Street Railroad Rails.*—Read by A. W. Wright before the Western Soc. of Engineers, May 5, 1885. Shows that the conditions of traffic on street and ordinary railroads are very dissimilar, and goes to prove that iron and steel wear almost equally well, while the former command a better price when old. *Journal of the Assoc of Eng. Societies*, June, 1885, pp. 314 to 319.

Rarified Air.—*Transmission of Motive Power to a Distance by Rarified Air.*—A lengthy paper by M. Boudenoot. It gives the history of the subject and describes other methods adapted, viz., teledynamic cables, steam, water, electricity, gas, and compressed air. The subject is dealt with exhaustively both as to mathematical points, engines and plant, management and other matters of actual practice. Formulæ, tables, and several drawings are given *Memoires de la Société des Ingénieurs Civils*, March 1885, pp. 371 to 454.

Market Report of Engineering Materials.

New York, July 9, 1885.

Note.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

Structural Iron.			
Angles		1.9c. @	2.2c.
Tee		2.2 @	2.25c.
Beams and channels		3.0c. @	
Tank		1.9c. @	2. 0c
Shell		2¼c. @	2¾c
Steel plates, Tank		2¾c. @	3c.
Wrought-iron Pipe, Pittsburgh.			
Butt welded, black	Discount	45 @	50
" galvanized	"	35 @	40
Lap welded black	"	65c. @	
" Galvanized	"	45 @	50
Boiler tubes		60	
Rails.			
Steel (large lots at mill)		$27.00 @	27.50
Old rails		16.50 @	17.00
Old rail steel		16.50 @	17.00
R. R. spikes		1.8 @	1.9c
R. R. splice-plates		1.65c. @	1.75c.
R. R. Track Bolts		2.6c. @	3c.
Barb-wire fencing, galvanized		4¾c. @	5¼c.
" painted		3¾c. @	4¼c.
Corrugated iron			
Nails			
Iron		2.25	
Steel		2.25	

METALS.

Copper.		
Lake Superior	11.35 @	11.40
Other Brands	10⅞ @	11⅛
Lead.		
Com. Domestic	3.65 @	3.70
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
Zinc.		
Sheet	0.05 @	0.05½

BRICK.

(Cargoes afloat)		
Haverstraw per M.	$6.25 @	6.50
Fishkill	4.75 @	5.50
Up-River	5.70 @	6.00
Jerseys	5.50 @	5.75
Long Island		
" pale		
Fronts.		
Croton red	13.00 @	14.00
" dark	13.00 @	14.00
" brown	12.00 @	13.00
Philadelphia pressed	24.00 @	25.00
Trenton "	24.00 @	25.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85.00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

Portland.		
Gibb's English 400 lbs. per bbl	2.75 @	2.90
K. B. & S. " "	2.85 @	3.00
Burham " "	2.70 @	2.85
Keene's fine " "	9.50 @	10.00
" course " "	5.00 @	6.00
Roman	2.75 @	3.50
Largerdorfer German "	2,55 @	2 80
Dyckerhoff, " "	2.90 @	3.25
Stettiner " "	2.60 @	2.65
Hanover " "	2.60 @	2.65
Vorwohler, Lion "	2,90 @	3.25
Alsen, " "	2.55 @	2.60
Fieve " "	2.40 @	2.50
Saylor's American	2.15 @	2.40
Windsor	1.00 @	1.1
Standard U. S. C. Co.		1.15
Cable's Portland	2.15 @	2.40
Rosendale cements	1.00 @	1.10

LIME.

Rockland common per bbl	1.00
" finishing	1.20
State, common	.90
" finishing	1.10
Kingston, ground	0.95
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0,75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York

Pine, Common box per M.	16.00 @	20.0
Choice "	55.00 @	80.
Tally plank, 1¼ in. 10 in. dres'd. each.	.44 @	.5
Tally boards, dressed com. "	.28 @	.30
Spruce, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
Hemlock, Boards each.	.18 @	.20
Joist, 2½ × 4 to 4 × in	.17 @	.44
Oak per M.	55.00 @	65.00
Cypress 1, 1¼, 2 and 2½ in "	35.00 @	40.00
Yellow Pine, Girders "	26.00 @	35,00
Dressed flooring "	30.00 @	40.00
Shingles, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
Lath, Cargo rate	2.40 @	2.50

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" " in oil pure "	.05½ @	.05¾
English, B. B. in oil	.08½ @	.08¾
Red, American	.05½ @	.05¾
Litharge "	.05 @	.05¼
Venetian red, American "	.01 @	.01¼
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11¼
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¼ @	.01½
Drop black, Amer.	.08 @	.12
" "	.09 @	.11¾
Chrome green	.05 @	.15
Oxide zinc, American	.03¼ @	.04
" French	.06¼ @	.06¾

Ventilation means letting out foul air and letting in the pure. Vitiated air means headache, indigestion, and a predisposition to disease. Epidemics invariably spread where the air is bad. All ages need pure atmosphere, but with regard to children it is particularly necessary. Ventilators should be in every room; no chimneys should be allowed to remain with the ventilator down, and a perforated window-frame has stopped much disease.